# AUTOMOTIVE INDUSTRIES
The AUTOMOBILE

Reg. U. S. Pat. Off.
Published Semi-Monthly

Volume 81 Number 10



JULIAN CHASE, Directing Editor
HERBERT HOSKING, Editor
P. M. HELDT, Engineering Editor — J. B. POLLOCK, Ass't Editor
JOS. GESCHELIN, Detroit Technical Editor — MARCUS AINSWORTH, Statistician
J. A. LAANSMA, Detroit News Editor — HOWARD KOHLBRENNER, Art Editor
JEROME H. FARRIS, Ass't Editor — L. W. MOFFETT, Washington Editor
H. E. BLANK, JR., Ass't Editor — JAMES G. ELLIS, Washington Editor
B. M. IKERT, Chicago Technical Editor


## CONTENTS


Latest Developments in Metals Shown at Twenty-first Exposition. *By Joseph Geschelin* ..... 517
Business in Brief ..... 519
Double Standards Confuse Labor Issues. *By Julian Chase* ..... 520
Just Among Ourselves ..... 523
Buick Engine Balanced After Assembly ..... 524
New Developments in Automotive Materials ..... 526
Hydra-Matic Transmission on '40 Olds ..... 528
Duo-Grip a New Brake Design ..... 533
Gasoline Engine Combustion (Part One). *By Hector Rabezzana, Stephen Kalmar and Alfred Candelise* ..... 534
Engineering Drawings of Scammell Four-Cylinder Engine ..... 543
Credit to a Craftsman ..... 545
Men and Machines ..... 546
News of the Industry ..... 549
Advertisers' Index ..... 78


Copyright 1939 by Chilton Company (Inc.)


C. A. MUSSELMAN, Pres.; J. S. HILDRETH, Vice-Pres. and Manager, Automotive Division; G. C. BUZBY, Vice-Pres.

OFFICES

Philadelphia—Chestnut & 56th Sts., Phone Sherwood 1424
New York—239 W. 39th St., Phone Pennsylvania 6-1100. Chicago—Room 916, London Guarantee & Accident Bldg., Phone Franklin 4243. Detroit—1015 Stephenson Bldg., Phone Madison 2090. Cleveland—609 Guardian Bldg., Phone Cherry 4188. Washington—1061 National Press Bldg., Phone District 6877. San Francisco—444 Market St., Room 305, Phone Garfield 6788. Los Angeles—6000 Miramonte Blvd., Phone Lafayette 5525. Long Beach, Cal.—1595 Pacific Ave., Phone Long Beach 613-238.
Cable Address .....Autoland, Philadelph'a

Member of the Audit Bureau of Circulations
Member Associated Business Papers, Inc.

Automotive Industries—The Automobile is a consolidation of the Automobile (monthly) and the Motor Review (weekly), May, 1902; Dealer and Repairman (monthly), October, 1903, the Automobile Magazine (monthly), July, 1907, and the Horseless Age (weekly), founded in 1895, May, 1918.

Owned and Published by

CHILTON COMPANY
(Incorporated)
Executive Offices
Chestnut and 56th Streets, Philadelphia, Pa., U. S. A.



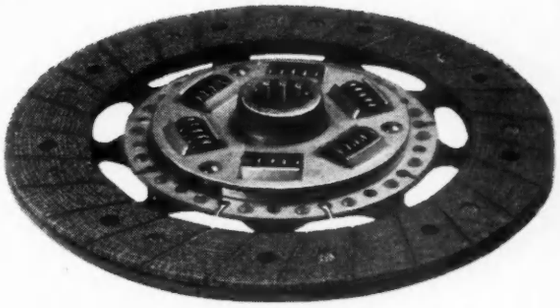
Officers and Directors
C. A. MUSSELMAN, *President*
FRITZ J. FRANK, *Executive Vice-President*
FREDERIC C. STEVENS, JOSEPH S. HILDRETH, GEORGE H. GRIFFITHS, EVERIT B. TERHUNE, *Vice-Presidents;* WILLIAM A. BARBER, *Treasurer;* JOHN BLAIR MOFFETT, *Secretary;* JOHN H. VAN DEVENTER, JULIAN CHASE, THOMAS L. KANE, CHARLES S. BAUR, G. CARROLL BUZBY, P. M. FAHRENDORF.



"PAUL PRY" says...

ONE MILLION '39 OWNERS DEMONSTRATE ADVANTAGES OF BORGLITE DRIVEN PLATE

"PAUL PRY," who hears about automotive improvements as soon as they happen, predicted success for Borg & Beck's new Borglite Driven Plate early in '39. He called the turn perfectly—already over 1,000,000 new car owners have found that their short leverage steering post gear shifts are both practical and extremely easy to operate. That this newly developed Borglite plate is largely responsible for easy shifting is of no consequence to car owners—but it is important to you! Better look into it.



1. Because this entirely new Borglite driven plate is *lighter*, the new short leverage gear shifts can be operated with finger touch control.
2. Light as it is, the Borglite driven plate loses nothing in strength. Cushion segments of waved "clock-spring" steel of uniform thickness and shape bring facings into full contact, permitting tailoring of the clutch to each customer's requirements.
3. The weight is saved at the outside edge to cut spinning time. The result—faster, easier and quieter gear operation—smooth, positive clutch action.

BORG & BECK
DIVISION
BORG-WARNER CORPORATION
CHICAGO, ILLINOIS




AUTOMOTIVE INDUSTRIES, Vol. 81, No. 10. Published semi-monthly by Chilton Co., Chestnut & 56th Sts., Phila. Entered as Second-Class Matter October 1, 1925, at the Post Office at Philadelphia, Pa.; Under the Act of Congress of March 3, 1879. In Case of Non-Delivery Return Postage Guaranteed. Subscription price: United States, Mexico, United States Possessions, and all Latin-American countries, $1.00 per year. Canadian and Foreign, $2.00 per year; single copies, 25 cents, except Statistical Issue (Feb. 25, 1939), 50 cents.

# Announcing
## The NEW
# Barber-Colman
## Vertical
## HOBBING MACHINE

For combined high production, precision and finish; quick change-over; maximum work from each hob . . . the Barber-Colman Type V Vertical Hobbing Machine presents many new and profitable possibilities.

**Vertical Design** — Unique vertical design of the Barber-Colman Type V contributes to simplified construction, saves floor space, gives complete accessibility from front and rear. Large, deep-section columns are twin pillars of strength, solidly secured to the deep, heavy base and capped by a rugged crown member . . . makes frame of enormous strength and rigidity. Other advantages occur naturally because gravity intensifies stabilizing effect as the work-slide feeds *upward*, aids rapid traverse *downward*; causes chips and coolant to fall directly into the chute provided for them.

**Automatic Cycle** — The automatic operating cycle combines most effectively, *hydraulic* pressure for actuating the hob carriage, clutches, and clamping means . . . *mechanical* drives to hob spindle, and screw-feed . . . *electrical* drives to hydraulic unit, coolant pump, and work-slide rapid traverse. Cycle includes conventional or climb cutting as determined by setting controls.

**Easy Set-Up** — No time need be wasted in setting up a B-C Vertical. Speed, feed, and index gears can be selected quickly, mounted easily. Positive depth of cut, and movement of work-slide, are established by simple adjustments. Central controls give operator complete command of individual movements in cycle.

**High Quality** — Barber-Colman high standards for materials and workmanship are maintained consistently. Shafts are short; gears are hardened and lapped, run quietly at high speeds; drive shafts are mounted on anti-friction bearings. All of these advantages contribute to the establishment of new high production records, while maintaining extremely close limits of accuracy and providing a new high degree of fine finish on mass-production work.

BARBER B-C COLMAN PRODUCTS

HOBS, HOBBING MACHINES, HOB SHARPENING MACHINES, REAMERS, REAMER SHARPENING MACHINES, MILLING CUTTERS, SPECIAL TOOLS

## Barber-Colman Company

General Offices *and* Plant, Rockford, Illinois, U. S. A.

AUTOMOTIVE INDUSTRIES

Published on the 1st and 15th of the month

Vol. 81, No. 10
November 15, 1939

# Latest Developments in Metals Shown at Twenty-first Exposition

By JOSEPH GESCHELIN

AMPLE evidence of the importance of metals and metal processing to all American industry was found in the all-time high attendance records established by the National Metal Exposition at the Chicago Amphitheater Oct. 23-27. Swelled by a splendid turnout of the four technical societies comprising the National Metal Congress—A.S.M., A.W.S., The Wire Association, and the A.I.M.M.E.—the first day of the show boasted an attendance of 11,000 By mid-week the registration, without counting several thousand complimentary cards issued to exhibitors and booth attendants, was 27,000.

This year's exposition—the twenty-first consecutive event—attracted 267 exhibitors, including the best known names in the field of metals, welding and metal processing. The huge International Amphitheater provided an excellent setting for the exhibit booths with its generous floor space and spacious aisles. In all the exposition occupied some 160,000 sq. ft.

***A few highspots of automotive interest gleaned from the 267 exhibits at the 1939 National Metal Exposition***

An analysis of the exhibits makes it possible to group the offerings of cooperating organizations into the following broad categories—steels; alloys; non-ferrous materials; cutting tool and die materials; metal working machinery; electro-plating processes; heat treating materials; heat treating equipment—gas-fired and electric furnaces; instruments and inspection and testing devices of all kinds; welding equipment and accessories; metal cleaning equipment; powder metallurgy; miscellaneous items not classified.

In general the displays covered the latest developments in their particular field and in a few instances presented entirely new processes. Due to the large number of exhibits and the comprehensive nature of their presentation, it would be quite difficult to cover each one. Therefore, a brief comment as to the nature of the displays, and a few high-spots just to illustrate a sampling of the developments they represent.

Among the largest of the exhibits were those of the steel and alloy producers—U. S. Steel Corp., and its cooperating subsidiaries; Republic Steel; Jones & Laughlin; Allegheny; Bethlehem Steel; and an imposing list of producers and suppliers of alloys such as Climax-Molybdenum; Molybdenum Corp.; International Nickel Co.; Electro-Metallurgical, and others. Timken Roller Bearing Co., too, had a display of its stainless steels and automotive alloys.

In the non-ferrous group were the exhibits of the Aluminum Co. of America, Dow Chemical, and The New Jersey Zinc Co., just to mention a few. The latter had an extensive display of die castings of many types and applications, emphasizing the die castings produced for the 1940 motor cars and trucks. Unusual feature of this display was a grouping of die castings to illustrate the principles of strength, complexity, of form and coring, economy, and accuracy inherent in the high purity zinc alloys.

P. R. Mallory, specialist in non-ferrous and powder metallurgy, showed the latest developments in its alloys for resistance welding electrodes, resistance welding dies and machine elements, tungsten and silver alloy contact alloys, and various other rare metals. Firth-Sterling, Carboloy, Haynes-Stellite, and others provided the modern background for the special cutting tool materials, principally the various types of cemented-carbides, and the Haynes J-Metal and other Haynes-Stellite cutting tool materials and hard surfacing alloys.

LaSalle Steel Co. had examples of its recently announced Stressproof No. 2 line of steels, featuring high strength and free machining qualities. Ingersoll Steel & Disc Division of Borg-Warner Corp., presented the Ingaclad stainless-clad steel sheets and plates which make possible marked savings in material cost where only the surface need have stainless properties.

One of the most exciting prospects held out to metallurgists is the field of powder metallurgy whose commercial applications include—fabrication of high melting point metals, combinations of metals and non-metals as in oil-less bearings, development of unusual structures, formation of protective metal coatings, and as a means of replacing orthodox metallurgical operations. Among those specializing in various aspects of

EXPOSITION

this development are the Metals Disintegrating Co., who issued an interesting bulletin describing the field of applications and a comprehensive bibliography on the subject, the Metals Refining Co., specializing in iron, lead, and copper powders; and Charles Hardy, Inc., with examples of bearings, gears, stainless steels, magnets, tool steels, and friction clutches produced by powder metallurgy.

Mention can be made at this point of the "putting-on" tool, the Metco metallizing gun made by the Metallizing Engineering Co., which sprays many kinds of metals. Latest editions of the Metco guns include units for use with acetylene, hydrogen, and propane.

The field of electroplating has been enriched recently by the introduction of the Corronizing process by the Standard Steel Spring Co. This is a unique nickel coating, surfaced with zinc or tin in various proportions depending upon the degree of corrosion resistance required. Certain combinations of this coating have withstood as much as 500 hours in the salt spray test. Licenses for the use of this process already have been granted to Youngstown Sheet & Tube, Carnegie-Illinois Steel, Republic Steel, and others.

Most valuable attribute of Corronizing is said to be its ability to adhere to the surface of sheet metal even in drawing and forming operations, thus eliminating the need for metal cleaning and electroplating after forming. Important exponent of prefinished strip steel is the Acme Steel Co., whose Superstrip display drew attention to its line of electrocoated materials now widely used in the automotive industry. Coatings include—nickel, zinc, tin, cadmium and Colorstrip—and the metal can be fabricated without affecting the adherence and protective properties of the coatings.

An interesting exhibit by du Pont included the new moly-Black nickel plating process, the high speed copper electroplating process, and other contributions to the electroplating art introduced by du Pont during the past year or so.

Welding in all of its ramifications—the electric arc, torch and resistance welding—was well represented by outstanding organizations such as Lincoln Electric Co., General Electric, Westinghouse, Air Reduction Sales, Linde and others. Allis-Chalmers presented its Weld-O-Tron, a new low current electronic welder for the fabrication of light sheet metal assemblies. National Cylinder Gas Co. showed its new flame-hardening and flame cutting equipment. Air Reduction Sales had an impressive display of applications of the oxy-acetylene flame and demonstrated for the first time its Planograph flame cutting machine.

The resistance welding industry was represented by the Resistance Welder Manufacturers Assn., which is inaugurating a series of bulletins on the process. The first of these was distributed at the exposition.

Both General Electric and Westinghouse had spacious booths displaying other products and services, including heat treating equipment. G.E. had some new X-Ray apparatus, the central item being the new equipment or X-Ray diffraction procedures. Westinghouse had a special demonstration of its Phos-Copper brazing alloy which is recommended for various types of assembly operations.

Heat treating processes and equipment certainly took a leading part in the proceedings. One large section was devoted to the American Gas Association and the cooperating organizations whose equipment uses gas burners. One of the interesting exhibits was that of Holcroft & Co., whose controlled atmosphere heat treating furnaces have been used in gear production in the automotive industry. Another prominent supplier of heat treating equipment of various kinds was the Surface Combustion Corp. They distributed an interesting bulletin describing many examples of their service.

A new nitrogen generator producing controlled $N_2$ for wire annealing, for gas carburizing, bright hardening, bright annealing, etc., was announced by the Mahr Mfg. Co. The American Cyanamid & Chemical Corp., showed its new Aerocarb carburizing compounds which are said to provide rapid and uniform hardening and permit easy washing of the surface. E. F. Houghton had

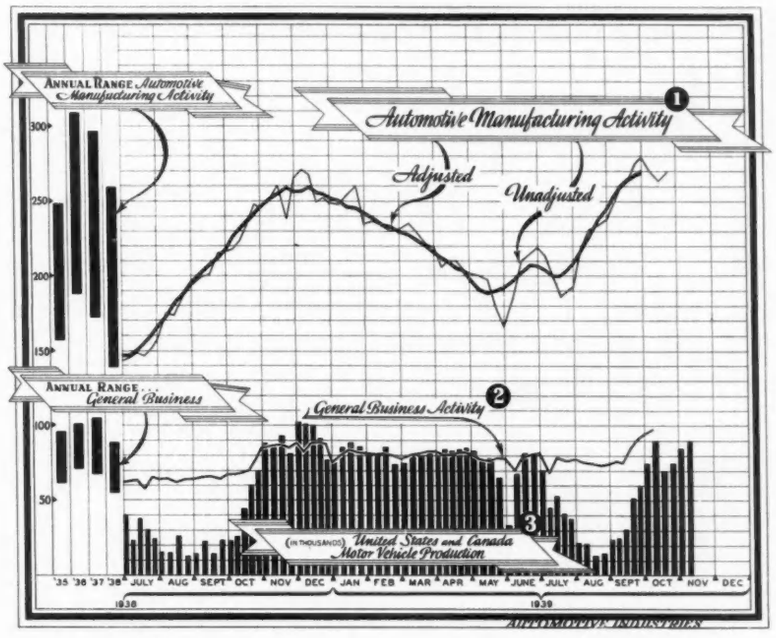
(*Turn to page* 556)

## *The Brass-Hat Rack*

***"This is a helluva note—All the parts manufacturers come through on schedule!"***

# BUSINESS IN BRIEF

***Our own view of automotive production and sales; authoritative interpretation of general conditions***




***Weekly indexes of automotive general business charted***

# Unfilled Orders Press Production

PRODUCTION of cars and trucks during the first two weeks in November continued to climb steadily to meet the growing banks of unfilled orders being reported by dealers as the result of sales stimulated by widespread acceptance of the 1940 models.

Even though the normally important contribution made by all divisions of the Chrysler Corp. was missing from the estimates of production for this period because that company was still completely tied up by a UAW-CIO strike, output for the two-week period ending Nov. 11 is estimated[3] at approximately 175,000 cars and trucks. Of this total approximately 33,000 units will be credited to October production to bring estimates for that month in the neighborhood of 320,000 cars and trucks and to start November with approximately 142,000 units.

Production for the week ending Nov. 4 was expected to reach an estimated total close to 85,000 cars and trucks and the following week was expected to be at least 5000 units better, barring any additional labor outbreaks. Increases over the previous periods could be attributed largely to continued acceleration of output by Chevrolet and Ford, accompanied by step-ups in several other GM divisions and maintenance of a steady pace by all other producers.

Both Chevrolet and Ford reported accumulated unfilled orders in the vicinity of 100,000 cars and trucks with a number of other manufacturers reporting large banks of unfilled orders in spite of sales through October which were heavier than for any comparable period in recent years.

[1] 1923 average = 100; [2] Prepared by Administrative and Research Corp., New York. 1926 = 100; [3] Estimated by J. A. Laansma, Detroit News Editor, AUTOMOTIVE INDUSTRIES.

If all manufacturers maintain the production rates in effect during the first full week in November, and there is reason to believe that some of them will increase their schedules, output for November should be better than 340,000 cars and trucks. This is a minimum figure which takes into account no production by any of the Chrysler divisions. Settlement of the Chrysler strike would see November production boosted considerably.

Shortly after beginning production on its 1940 models, Ford Motor Co. announced that it expected to build at least 250,000 cars and trucks during the last quarter of 1939, and at about the same time Chevrolet schedules for the last quarter were set at 200,000 passenger cars and 60,000 trucks. With these two important producers planning to turn out more than half a million cars and trucks between them there is every reason to believe that the industry's total production for the last three months of 1939 will pass the million unit mark in spite of the serious effect of labor troubles on the industry's output.

Official production figures compiled by the United States Department of Commerce place September output in the United States and Canada at 192,672 cars and trucks.

AUTOMOTIVE MANUFACTURING ACTIVITY dropped seven points and regained them again during the weeks ended Oct. 21 and Oct. 28, respectively. As indicated by the unadjusted index charted above the curve moved through the points, 263 and 270. The adjusted index continued its steady rise, mounting to 268 for the week ended Sept. 30 and to 270 for the week ended Oct. 7.

# Double
# Confuse

*In 1937, the seizure of General Motors, Chrysler, Hudson and Reo property by sit-downers meant to workers, in those plants alone, an immediate wage loss of nearly 45 million dollars. Free choice of bargaining representatives was denied to great masses of employes. In the center photograph above we see picketing pressure on the home of a worker during a strike this summer to persuade his family that it's best for him to join the union. The small inset shows a strong-arm squad at work on a sheriff's car. The sheriff is inside. At the extreme right a labor organizer expresses his attitude toward the law.*

Photos from Acme, International and Pictures, Inc.

*Chart above shows number of strikes in all U. S. industry before and after Wagner Act. Figures from report of Committee on Industrial Problems and Relations of Chamber of Commerce of State of New York.*

# Standards Labor Issues

By JULIAN CHASE

IN THAT large and tremendously important part of our national life which is affected by legally controlled labor relations we have, during the past few years, befuddled ourselves into a completely confounded condition. And not only that. We have, at the same time, further and more fundamentally confused ourselves into nonsensical contradictions as to what is right and what is wrong, as to what is helpful and what is harmful in consideration of the general welfare.

We have set up circumstances in which a well grounded reason for the restraint of one group of citizens appears to be no reason at all for the restraint of another group when the actual economic and social effects of the action to be or not to be restrained are exactly the same in either case. It's not what's done, our laws say, but who does it.

Is monopoly pernicious? If it's a labor monopoly controlled by professional organizers, no. If it's an industrial monopoly, it should be broken up or at least strictly regulated with heavy penalties for law violators.

Is interference with interstate commerce harmful to the general welfare? Yes, of course, and if industrialists do the interfering, prosecution follows. But, if so-called labor leaders do it, even though it be only for their own enrichment and aggrandizement, it is unfortunate, but that's all that can be said and nothing can be done about it.

Is free speech a constitutional right of American citizens? If they are labor agitators, yes, and that sacred right must be protected. If they are employers who want to tell their employes some wholesome truths which those employes, in their own interest ought to know, the only answer that such employers can safely heed is a positive and penalty-threatening no.

Are intimidation and coercion evil? The answer of the law, apparently, is either "yes and no" or "it depends," but for a better, more definite and more forceful answer we should ask any of the thousands of stable, self-respecting, American-minded men who in late years have been subjected to continuingly cruel harassment by ruthless organizers, not only within our automotive plants but on the streets and in their homes, during the process of unionization. Such men, in tremendous numbers, have been threatened and assaulted, they have been prevented from entering supposedly open-shop plants when they could not show union cards as receipts for paid-up union dues, their clothing and lunches have been destroyed while they were working, their tools have been stolen, the windshields of their cars have been broken, the tires cut, their homes have been invaded and their families threatened.

All this has happened according to many published

*At Right—The sentiments on the banners displayed by this large group of workers during one of the strikes in 1937 are not publicly expressed today. A fair question is: To what extent are coersion and intimidation responsible?*

*"I want to know," said the wife of an automotive worker, "when my husband goes to work whether he'll come home alive or be brought home dead."*

Photos from International and Acme

*Above—The mob method of collecting dues. In such persuasive ways are workers in supposedly open shops convinced that it pays to join the union and pay up.*

statements, documents filed with the Labor Board and testimony offered to Congressional committees. It has happened even in direct violation of union agreement that "neither the union nor its members will intimidate or coerce employes." It has happened in spite of common law and in contravention of civil liberties. But what has been done about it?

Let's glance for a moment at what has recently transpired in the Detroit area. We will look at other cases later.

The no-intimidation clause from which the quotation above was taken is in the contract that was signed by the Chrysler Corporation and U.A.W.A.-C.I.O. early in 1937 to run until Sept. 30 this year. The contract has in it another clause which reads as follows:

> "The union will not cause or permit its members to cause, nor will any member of the union take part in, any sitdown or stayin strike or other stoppage in any of the plants of the corporation during the term of the agreement."

During the period in which the contract was in effect there were, according to a statement issued by the corporation, "among other contract violations: 84 strikes and stoppages of production, 65 'slow downs'; 64 evictions from plants, involving 91 employes; 18 instances of plant picketing, principally to collect dues; 100 cases of intimidation involving 136 employes."

"Inside and outside the plant," said Herman L. Weckler, vice-president in charge of operations, "the claim of collective bargaining has been distorted into a systematic, organized campaign to control the individual employe, to dictate how much work he does and to force him by intimidation and threats of violence to do the union's will.

"Inside the plant this sort of thing is carried on by an army of 'white button' stewards working under shop committee men and district committee men who defy the factory management and tell foremen what the men will and will not do.

"Outside the plant it is carried on by flying auto squadrons of C.I.O. agents who so intimidate the men that they are afraid to do their work for fear of violence to themselves and to their families.

"The union denies this. It also denies 'slow downs'

(*Turn to page* 557, *please*)

AUTOMOTIVE INDUSTRIES

# Just among Ourselves

IN RECENT years we have come to associate certain operating advantages, such as low engine speed, low fuel consumption, smooth engine operation, and reduced engine wear and tear with the installation of an overdrive. These advantages, however, can be had also without an overdrive, as they are dependent solely upon the relation between the car gross weight, the engine displacement, the gear ratio, and the diameter of the driving wheels. In fact, an overdrive as now supplied on several car models is essentially an auxiliary transmission which in combination with the regular one gives the car four forward speeds. The combination differs from the ordinary four-speed transmission chiefly in that with the former the change from third to fourth gear, or vice versa, ordinarily is effected automatically, whereas with the conventional transmission the shift must be made by hand.

In spite of increases in the compression ratio, streamlining of cars, and other improvements tending in the same direction, the fuel economy of our modern cars, expressed in miles per gallon, is little if any better than that of cars of, say, two decades ago. That this is so is due to the fact that modern cars are powered for high performance, with the result that under normal driving conditions the engine is only lightly loaded or works with a low power factor, in consequence of which it operates uneconomically. Anything we may do to increase the power factor of the engine under certain driving conditions will increase its fuel economy under these conditions. For instance, a change in the rear-axle gear ratio such that the engine will make fewer turns per mile traveled will increase the economy. A decrease in the displacement of the engine, if the same gear ratio were retained, would have the same effect. Any such change, however, would also decrease the acceleration, or what is more generally referred to as the performance of the car. With a given piston displacement and a given gear ratio a car cannot have both high performance and high economy. It is, of course, impossible to change the engine displacement once the car is built, but it is possible to change the gear ratio, and the demand for high performance combined with high economy had led to the development of overdrives and of four-speed transmissions combined with low-ratio rear axles.

## Factors in Fuel Economy

THE relationship between the principal factors that influence the fuel economy and performance of a car is expressed by the "displacement factor" which is usually given in cubic inches displaced by the engine pistons under gas pressure per ton of gross vehicle weight per foot of car travel. Any change which lowers this factor tends to increase the economy and to decrease the performance. With four speeds in the transmission or in the "transmission-overdrive combination" it is possible to have both a low displacement factor resulting in low specific fuel consumption (in high speed or overdrive) and a high displacement factor and high performance (in third speed or direct drive).

During the past decade the average displacement factor of standard American passenger cars has risen from 32.4 to 37.4. Car performance has increased in even greater proportion, however, because compression ratios also have been increased, and the compression ratio is a further factor having an influence on car performance and fuel economy, which is not taken into account in the displacement factor.

With four available forward speeds the displacement factor in high gear (or overdrive) naturally is made considerably lower and the displacement factor in third gear (or direct drive) slightly higher than in the average car.

Another basis for the comparison of passenger-car performance is the number of engine revolutions per mile traveled in high gear or direct drive. In most of the normal-sized cars the engine makes approximately 3000 turns per mile, whereas the engine of a car equipped with overdrive makes about 3200 turns per mile in direct drive but only 2400 turns in overdrive. This comparison shows the advantage of the overdrive and of the combination of a four-speed transmission with a low-ratio rear axle in holding down the speed of the engine, thereby improving its smoothness of operation and lessening the wear and tear on its parts.

However, the engine revolutions per mile is not as broad a basis of comparison as the displacement factor, as the former disregards the relation between the piston displacement and the gross weight, and therefore does not permit of any conclusions as to relative engine loading, which latter determines the fuel economy and the performance. Decreasing the relative displacement tends to improve the relative fuel economy and impair the performance, and vice versa.

American passenger cars with overdrive have a considerably higher displacement factor (and therefore better performance) even in overdrive than some of the low-powered European small cars in direct drive (32 as compared with about 24). For fully loaded trucks in high gear the displacement factor is only about 12. This explains why our passenger cars are so much more "agile" than loaded trucks, but it also explains why with passenger cars we cannot approach the "ton-miles per gallon" achieved with trucks.—P. M. H.

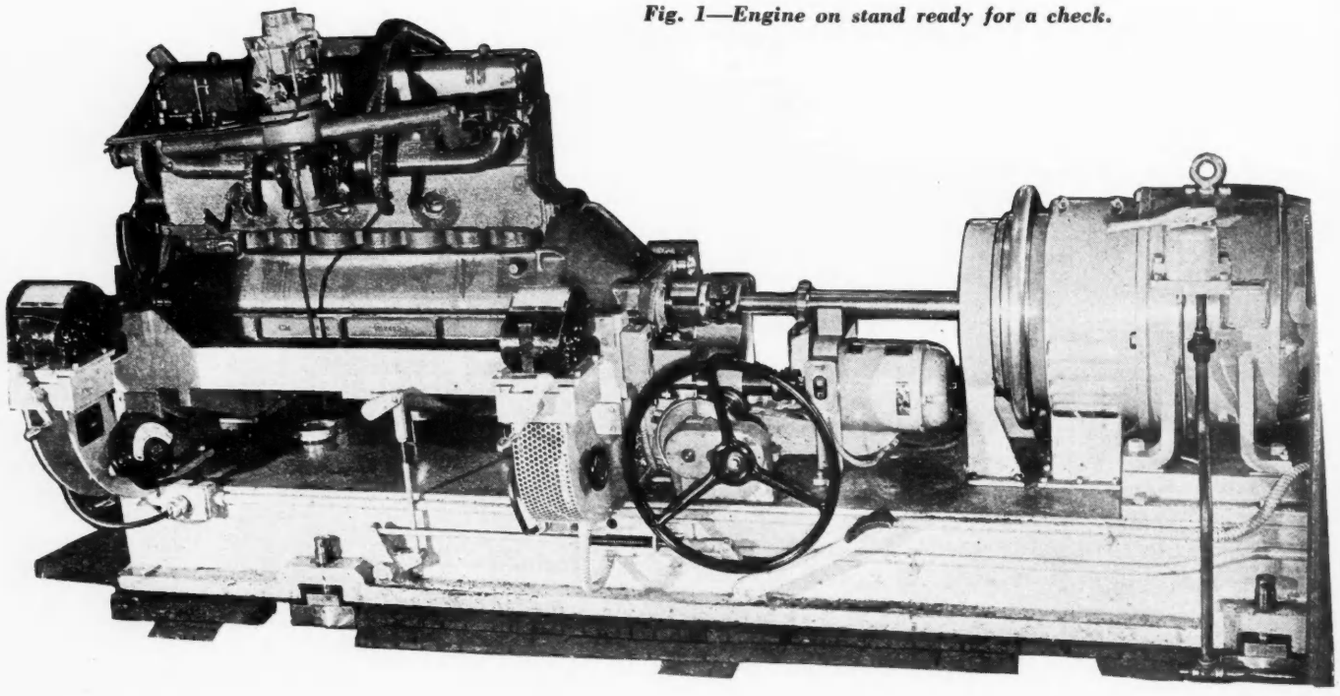


*Fig. 1—Engine on stand ready for a check.*

WITH increase in engine speeds it became necessary first to carefully match the reciprocating parts with respect to weight and then to balance not only the major but also some minor rotating parts. For many years now, such parts as the crankshaft, flywheel, clutch pressure plate, clutch driven disk have been balanced in suitable balancing machines, the permissible unbalances being held to quite low limits. On the whole, this method has given satisfactory results, but in a few instances the unbalances of the various parts will all be in the same direction, and if in addition most of them are close to the upper limit, the result is likely to be a degree of unbalance of the engine as a whole that results in serious vibration. In order to guard against such chance "stacking up" of unbalances in individual parts, Buick this year, in addition to balancing the individual parts, tests the completely-assembled engine on a balancing machine, and then corrects any unbalance that may be found. Testing an assembled engine for rotary unbalance naturally calls for an entirely different machine from that normally used for individual rotating parts. A machine was specially developed for this purpose and will be described further along in this article, after the balancing operations performed on the different parts of the engine have been described first.

Finished crankshafts are placed in dynamic balance within ½ oz.-in. in a number of successive steps. First the rough crankshaft is mass-centered on a special machine which determines and drills the centers of the crankshaft for machining operations. The crankshaft is then put through successive machining operations before being balanced. The balancing operation is performed on a General Motors balancing machine. This machine determines any out-of-balance condition, and correction is made by drilling the counter-weights of the shaft. The crankshaft then has all bearing journals and crankpins finish-lapped, the shaft is straightened, and then a final-balancing check on the G.M. balance machine is made.

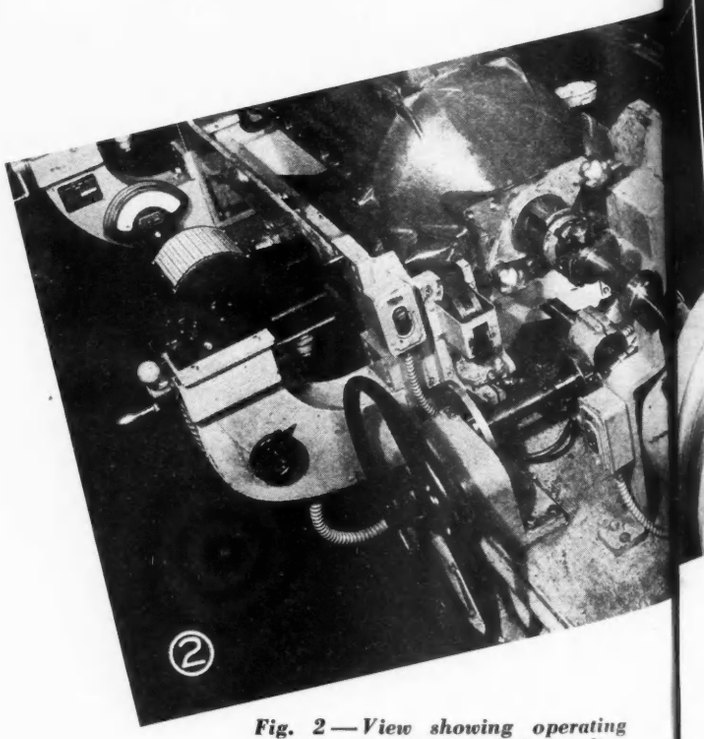


*Fig. 2—View showing operating controls and method of coupling drive motor to engine.*

The crankshaft-balancer assembly is balanced to within ¼ oz-in. by drilling at the outer edge.

Flywheel and ring-gear assemblies are balanced to within ½ oz.-in., in a specially-built G.M. balancing machine. The finished flywheel assembly is placed on a disk and spun. The machine registers and indexes the amount of unbalance, and the flywheel is then balanced by drilling at the outer rim.

***To overcome the possibility of the total of balance tolerances on separate parts creating an objectional out of balance condition, Buick has a new machine to balance the engine as a whole***

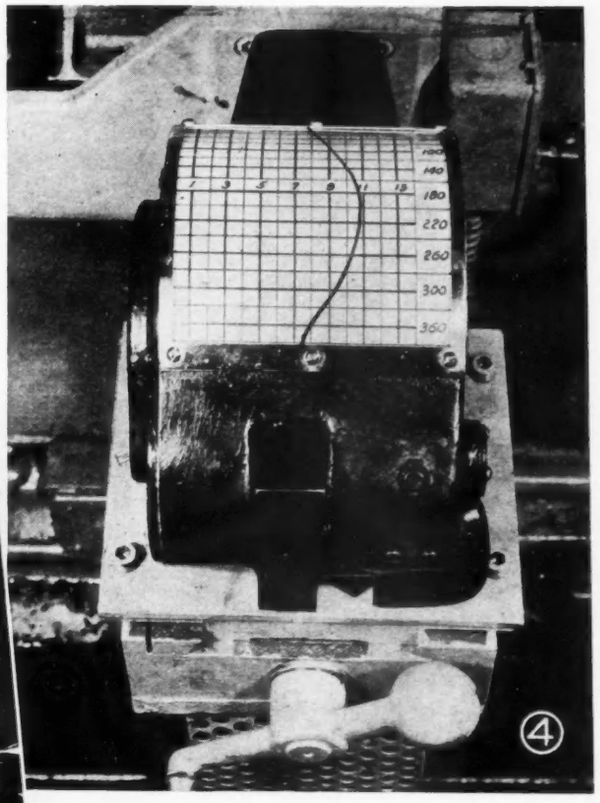



*Fig. 3—Test fixture, showing drive coupling and drill used for removing excess weight from flywheel; also, vibration pick-up pointer resting against engine bed at rear engine mounting.*

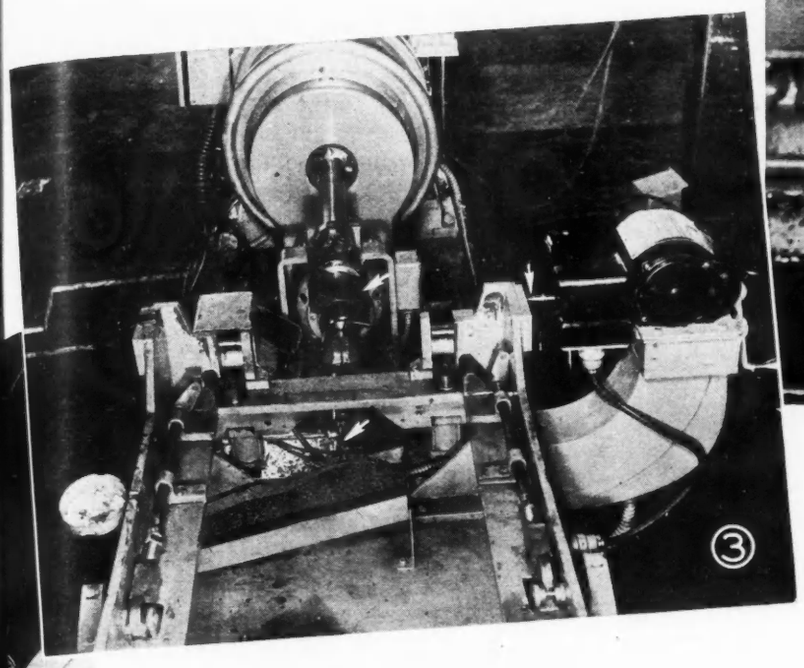



*Fig. 4—Vibration indicator unit with screen, showing typical curve produced by an engine out of balance.*

# Balanced after Assembly

Like the flywheel, the clutch pressure plate also is balanced on a G.M. balancing machine. It is checked and balanced by drilling at the outer edge in one operation, the unbalance being held to within ¼ oz.-in.

The clutch pressure plate and cover assembly are likewise balanced on a G.M. balancing machine, and this assembly is held to within ½ oz.-in. Drilling is done at the edge of the cover. All clutch driven plates are purchased as an assembly, and the limit on the unbalance specification is 3/0 oz.-in.

All pistons, after being finished, are weighed and balanced on a Morris balancing machine equipped with Toledo scales. The piston is weighed and automatically machined to within 1/16 oz. of the specified weight.

All connecting-rod and cap assemblies are weighed and marked as to weight. All eight rods for any one engine must be within ⅛ oz. of each other, with the additional requirement that the large and small ends of each assembly must be within ⅛ oz. of each other. All rod and piston assemblies are selected for bore size, and must be the same weight within ⅜ oz.

The new Buick engine-balancing machine was designed for the purpose of locating and correcting an out-of-balance condition which may be caused by a stack-up of production limits. This machine, which does not correct for vibration caused by faulty ignition, carburetion, or other uneven firing, is composed of three major units as follows:

Unit No. 1 consists of a bed for mounting the assembled engine and a 15-hp. electric motor which is used to drive the engine through the speed range where vibration occurs.

Unit No. 2 is a vibration indicator, or what might be described as a mechanical oscillograph, its operation depending upon the projection of a beam of light onto

(*Turn to page* 532, *please*)

# *New Developments in*

# AUTOMOTIVE

## Stainless Steel "Lumber" Offered by Allegheny Ludlum Steel Corp.

Stainless steel lumber recently placed in production by the Allegheny Ludlum Steel Corp., Pittsburgh, through its Ludlite division in Watervliet, N. Y., consists essentially of thin sheets of Allegheny Metal (18-8 stainless steel) permanently bonded to an inert mineral backing material to form strong, rigid panels of convenient building size. The Allegheny Metal 18-8 stainless strip is hot-rolled and then cold reduced to 0.0095 in., the thickness at which it is applied to the mineral backing.

The mineral backing material consists of asbestos fibres, Bentonite (volcanic clay), Portland cement and calcined magnesite. This material is processed under great pressure and bonded to the stainless steel facing by means of a special pressure-cementing process. Ludlite Bord, as the resultant product is called, is fireproof and weather-resistant. Coefficient of expansion of the backing material closely approximates that of the stainless so no distortion of the product occurs under any ordinary temperature. While the backing material will absorb moisture, such absorption does not cause the product to warp or distort.

Ludlite Bord is made in two standard size panels, 2 by 4 ft. and 2 by 8 ft. It comes in two standard thicknesses: ⅛ and ¼ in., weighing 1.54 and 2.5 lb. per sq. ft., respectively. The ⅛-in. panel is flexible enough to be bent 180 deg. to suit the requirements of an installation, without losing any of its flatness. The ¼-in. panel is extremely rigid and possesses high load-bearing strength.

## Machinability and Bessemer Flame Control

Considerable progress has been made in the past four or five years toward raising the average machinability of Bessemer steel. Noteworthy improvements have been made possible by the recent invention of the Jones & Laughlin Bessemer flame control, an exclusive method using an arrangement of photo-electric cells and other devices to provide accurate regulation of blowing conditions.

In the past, control of the Bessemer converter depended upon the skilled eyes of the blower who had sole responsibility in determining the proper "end point" or termination of the blow, which has a definite connection with quality results. The Bessemer flame control supplements the skill of the human eye by a method which operates instantaneously and without the variables of the human eye. Records of heats blown are reported to be showing a narrowed range of temperature of the steel at the end of the blow; improvement in freedom from surface defects; sounder structure in the center of the billets and bars; and a more even distribution of additions through the steel.

The following reports of machine operations in a variety of shops where Bessemer flame control steel has been tested under regular production conditions are cited by J & L as representative of the type of results obtained in meeting individual problems. In one case, machine speed was increased to 350 s.f.m., in cutting small steel pins from bars of BFC steel, S.A.E. X1112, with a resulting decrease in time per part from

24 to 12 sec. Another part, an adjusting screw, was cut at 265 s.f.m., from BFC steel, S.A.E. X1112, and the time per part reduced from 26 to 17 sec. One shop set a new high record of over 5500 pieces per tool grind when using BFC, S.A.E. 1112 steel, more than 1500 pieces better than any previous record. A guide bearing, cut at previous surface speeds and feeds, showed that BFC steel, S.A.E. 1112 grade, gave a superior finish.

## New Silicon-Brass Die-Casting Alloy

A new, high-strength, silicon-brass, die-casting alloy has been developed by A. U. Seybolt and B. W. Gonser, research engineers at Battelle Memorial Institute, Columbus, Ohio. Messrs. Seybolt and Gonser state that on the basis of excellent physical properties and economy, combined with a low melting range, the best high-strength, die-casting, copper-base alloy of a large number studied by them contains 83 per cent copper, 5 per cent silicon, 10 per cent zinc, 1 per cent manganese

# MATERIALS . . .

***Here are a few of the outstanding new materials that have come up over the automotive horizon recently***

and 1 per cent aluminum. Strength and ductility of the Seybolt-Gonser alloy can be varied to suit specific needs by altering the proportions of manganese and aluminum, the latter making the alloy very resistant to oxidation at high temperatures.

The investigation of silicon brasses for die-casting was sponsored at Battelle by the Union Carbide & Carbon Research Laboratories, Inc. Although developed primarily for die-casting the alloy can be successfully sand-cast.

## Hudson Speedometer and Gage Assembly Wins Award in Plastics Competition

A speedometer and gage assembly developed by Hudson Motor Car Co. was awarded Honorable Mention in the Transport division of the fourth annual Modern Plastics competition, sponsored by *Modern Plastics* magazine.

The lens on the odometer of this assembly consists of a molded piece in the shape of a half rod of transparent plastic material designed to give two times magnification at right angles to the eye. For assembly, the lens simply snaps into the face of the panel. Made of Lucite, product of E. I. du Pont de Nemours & Co., Inc., Arlington, N. J., these lenses are molded by the Watertown Mfg. Co., Watertown, Conn., in an injection press made by Reed-Prentice Corp., Worcester, Mass.

The speedometer lens is molded of the same material by Norton Laboratories, Lockport, N. Y. Arthur H. Kibiger, Detroit, is responsible for the design of the assembly.

## Atomic Welding Paste and Rod

Colonial Alloys Co., Phliadelphia Pa., has developed a new method for atomic welding of virtually all nonferrous metals, including aluminum, in connection with aluminum and aluminum alloys. In this method, Colalloy atomic welding paste is brushed onto the metal at the points where the welding is to take place, rod applied, and the work heated at approximately 450 deg. Fahr. In a matter of seconds, the weld is completed. The bond it atomic and, while this process is not offered as a substitute for welding by regular methods now in use, this form of welding can be employed in many applications which heretofore presented a problem in the joining of metals by other than mechanical methods.

Gages from 0.005 in. to 0.050 in. lend themselves more readily to this procedure. While strength at the weld depends in part upon the gages of metal used, the company reports that it has found in virtually all cases that the weld is stronger than the metal which it joins. In a tensile test recently completed on atomically welded 18 gage aluminum alloy sheets, the machine recorded 40,000 lb. per sq. in. at the point where the metal above the weld started to tear. Examination indicated that the original weld remained intact. It is pointed out that the recorded loss in tensile strength of the welded metals in this case amounted to but about 20 per cent.

Colaweld, as the method is called, also can be employed to atomically weld most other metals, both ferrous and non-ferrous, such as monel, nickel, copper, brass, bronze, Everdur, nickel-silver, aluminum, duralumin, lead, zinc, low and high carbon steels and stainless steels.

## Rust Preventative and Protective Coating for Metal Products

New rust preventative and protective coating for steel, brass and virtually all metal products is Metaseal 494, product of Estox Products Co., New Haven, Conn. Metaseal 494 may be applied by dipping, spraying, brushing, etc., and requires no special equipment for application.

Claims made for the product are that it will definitely seal clean metal products; cold rolled, forged, machined or ground, for a period of nine to 12 months, either in storage or during shipment or while in process through the plant. If applied to fine machine parts it may in some cases be necessary to remove it before assembly. This may be done by a bath in thinning solution and regular factory washing or cleaning in any of the standard cleaning solutions or in a special cleaner supplied by the Estox company.

# Hydra-Matic

With the adoption of its new Hydra-Matic transmission, Oldsmobile has done away with the conventional friction clutch and clutch pedal. Despite the automatic character of the device, the operator has complete control over it under all circumstances, by means of the shift lever and the accelerator pedal. The shift lever has four distinct positions, viz., "Neutral," "Hi," "Lo," and "Reverse," which are reached in the order named by a continuous motion. When the engine is being started, the shift lever is in "Neutral." Finger-tip shift direct from "Neutral" into "Hi" is all the shifting required under normal conditions, since the transmission will shift automatically from first to fourth through the intermediate gears, at predetermined road speeds varying with the throttle position, and with the engine idling the car will not move when in the driving positions.

When the shift lever is shifted manually into "Lo," the transmission can operate in first and second gears only. It will shift automatically from first to second at a road speed which varies with the throttle position. The "Lo" position of the shift lever is to be used only in emergencies, on extremely steep grades, and when it is desired to use the engine as a brake; it need practically never be used in normal operation.

A valuable feature of the transmission is that the car can be locked positively on a grade when the engine is dead by placing the shift lever in reverse. This is effected by means of a spring-loaded band on the rear unit which locks the reverse unit.

The entire transmission is filled with a fluid lubricant covered by precise specifications. At the start this fluid will be packaged for Oldsmobile and carried exclusively in its various branches and service stations. Close specifications are necessary mainly to prevent formations of varnish, and because the fluid must function properly under extremes of temperatures. We are informed that the fluid specified has been found satisfactory at an atmospheric temperature of 115 deg. Fahr. (in Death Valley), and down to minus 15 deg.

An important feature of the mechanism is the influence of the throttle (or accelerator pedal) position on the road speeds at which gear changes take place. At part throttle, any particular shift takes place at a lower car speed than at full throttle. This, of course, is highly desirable, for when one wants to accelerate rapidly, the accelerator is pushed far down, and the transmission then remains in a given gear up to a higher road speed than it otherwise would, which results in a higher rate of acceleration. In general, with the throttle fully open, the shift from first to second occurs at around 15 m.p.h.; from second to third, at 30 m.p.h., and from third to fourth (direct drive), at 65 m.p.h.

The housing of the fluid coupling, which is sealed, receives its actuating fluid directly from the transmission housing, to which the fluid returns through a pop-off valve and a separate return line. This constant circulation of the fluid prevents localization of temperature effects and keeps down peak temperatures.

The transmission consists essentially of four units. Within the engine flywheel there is a fluid coupling; then come—one behind the other—two planetary gear sets of the type comprising an internally-toother ring gear, a central sun gear, and planetary pinions in mesh

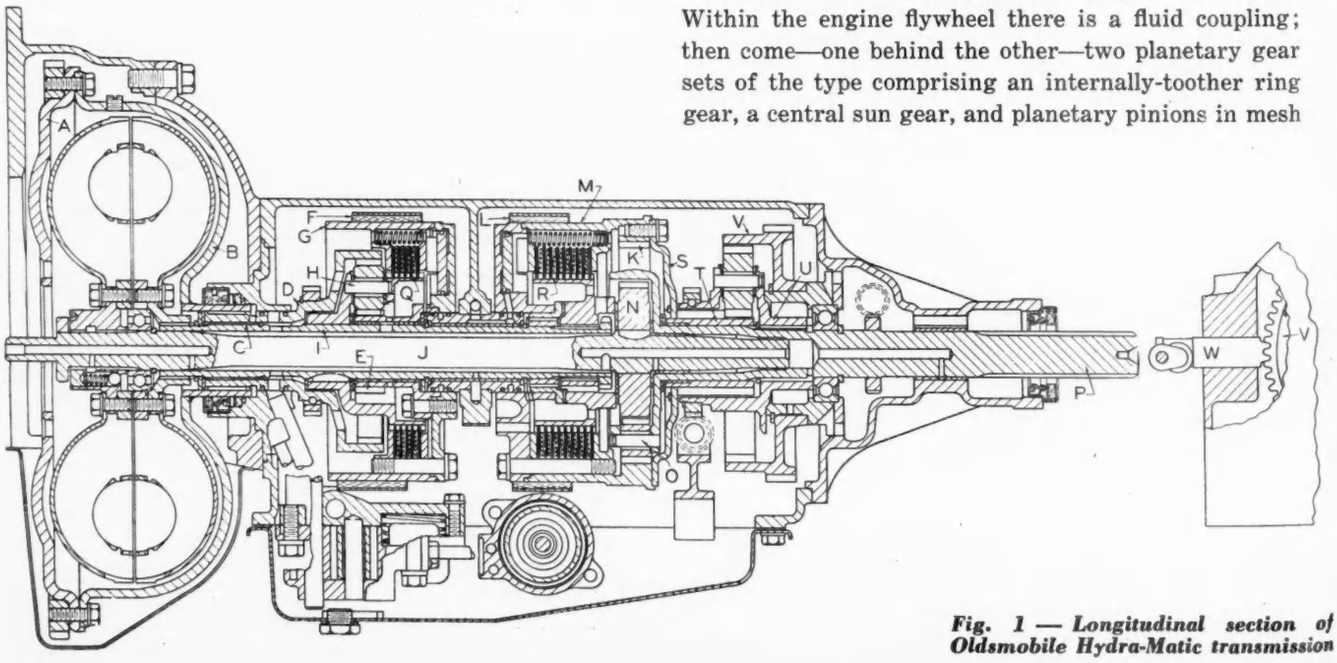



*Fig. 1 — Longitudinal section of Oldsmobile Hydra-Matic transmission*

# Transmission on '40 Olds

## *gives operator complete control by means of a shift lever, obviating conventional clutch and pedal*

with both the ring gear and sun gear; and finally, in the rear part of the transmission housing, there is a reversing gear, also of the planetary type. Each of the planetary units employed in forward drive is provided with a brake band, by means of which one of its members can be held from rotation, and with a clutch by which the whole unit can be locked together to transmit the power directly. These two units are referred to as the front unit and the rear unit, respectively.

Referring to the longitudinal section, flywheel *A* is bolted to the engine crankshaft, while fluid coupling cover *B* is bolted to the flywheel and is splined at *C* to the front-unit drive-gear *D*. For first gear, sun gear *E* of the front unit is held from rotation by brake band *F* applied to drum *G*. Planet-carrier assembly *H*, which now rotates at 0.694 times crankshaft speed, is keyed to the intermediate shaft *I*, which in turn is splined to the impeller of the fluid coupling. The runner of the fluid coupling is splined to main drive shaft *J*. From the main drive shaft the power passes on through the rear unit, whose ring gear, *K*, is held from rotation by brake band *L* acting on drum *M*, sun gear *N* causing the rear-unit planet-carrier assembly *O* to rotate at 0.395 of the speed of main drive shaft *J*. Rear-unit planet-carrier *O* is integral with output shaft *P*, which rotates at 0.694 x 0.395 = 0.274 times crankshaft speed.

The brake band of the front unit is applied by hydraulic pressure, while the brake band of the rear unit is applied by both spring and hydraulic pressure. The fluid coupling is kept filled under pressure by an oil pump.

In second gear, the front unit is locked by clutch *Q*, so that cover *B* is coupled to the impeller of the fluid coupling, and only the rear planetary unit is active, which, as already mentioned, gives a reduction to 0.395 times crankshaft speed. When in second gear, the front-unit brake band is released by hydraulic pressure, while the front-unit disk clutch is engaged by hydraulic pressure.

In third gear, the front planetary unit is active again, the same as in first gear. When the power enters intermediate shaft *I* the torque is divided, approximately 40 per cent passing to the fluid coupling, the remaining 60 per cent from the front unit rearward through intermediate shaft *I* to disk clutch *R* and ring gear *K* of the rear planetary unit. The portion of the torque transmitted to the fluid coupling is applied to sun gear *N* of the rear unit. With torque in the direction of crankshaft rotation applied to both sun gear *N* and ring gear *K*, planet-carrier assembly *O* and output shaft *P* are carried around with them—at 0.694 times crankshaft speed (neglecting slippage in the fluid coupling). The rear-unit brake band is released by hydraulic pressure overcoming spring pressure, while the rear-unit clutch is operated hydraulically.

In fourth gear both planetary units are locked, and the drive is then direct, except for the slippage in the fluid coupling.

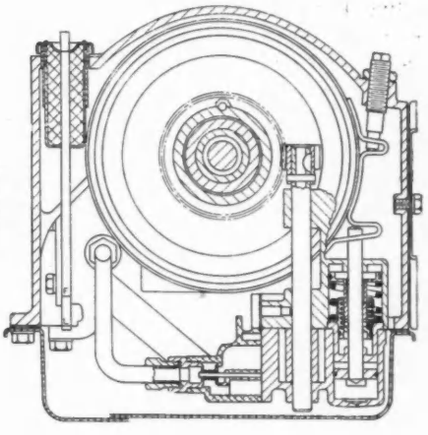


***Fig. 2—Transverse section showing oil pump at forward end of transmission.***

In reverse, the flow of power is the same as in first gear forward up to sun gear *N* of the rear planetary unit. Here the torque divides, part being applied to rear-unit planet-carrier *O*, the remainder to rear-unit ring gear *K*, which latter is connected through drum end *S* to sun gear *T* of the reversing planetary gear. That portion of the torque which is applied to rear-unit planet-carrier *O* (which is in driving connection with the output shaft) is combined with the remainder of the torque, which passes from rear-unit ring-gear *K* through reversing-unit sun gear *T* to reversing-unit planetary carrier *U* and thence to output shaft *P*. In this case the rear unit does not act as a planetary gear in the ordinary sense, as all three of its members are rotating. Sun gear *N* is the driver, while ring gear *K* and planet-carrier *O* are the driven members. The torque impressed upon planet-carrier *O* is transmitted

directly to output shaft *P*, while that impressed on ring gear *K* is carried through drum end *S* to sun gear *T* of the reversing unit, and after being modified in that unit, is transmitted through the reverse-unit planet-carrier *U* to output shaft *P*, to which the planet-carrier is splined. In reversing, the rear-unit brake band is released hydraulically and reversing "pawl" *W* is engaged manually with external gear teeth on ring gear *V* of the reversing unit, through suitable linkage.

Operation of the automatic feature depends upon two oil pumps which produce an operating pressure of 80 lb. per sq. in. There is a large pump at the front end, operated at engine speed, whose function is to produce pressure at starting, so as to establish actual running conditions. It will deliver the 80-lb. pressure immediately. The second pump, a smaller unit, is mounted at the rear end and is driven off the output shaft, as is the governor. The rear pump picks up the pressure as soon as the car moves, permitting the front-pump pressure to drop to around 20 lb. per sq. in.

The hydraulic control system is illustrated by the schematic diagram reproduced herewith. This system supplies the oil pressure necessary to actuate the clutch pistons and brake bands of the planetary units. Oil is admitted to the various cylinders at the proper time by a system of balanced valves; its pressure balances some variable force. In the case of the throttle valve, a spring pressure is balanced, while in that of the governor valve, the force balanced is centrifugal.

Referring to the diagram, oil is admitted to the body of the governor valve through the 80-lb. line from the pump. The governor is driven from the transmission output shaft, and as it spins, the centrifugal force so positions the valve that a port is opened and some of the oil is admitted to the valve, with the result that a pressure is built up which opposes the centrifugal force acting on the valve. This results in a governor pressure which increases with car speed. This governor pressure is applied to one end of a shifting valve, as, for instance, the valve which makes the shift from third to fourth gear. To the opposite end of this valve is applied a fixed spring pressure and another variable, hydraulic pressure known as the throttle-valve pressure. This latter pressure is determined by the position of the throttle, and is regulated by another balanced valve, as shown in the sketch.

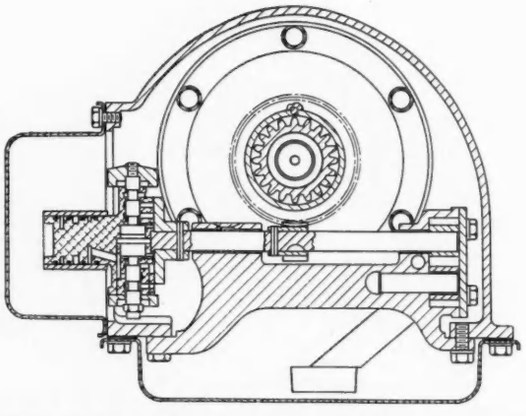


***Fig. 3—Showing drive of oil pump (right) and governor (left) through helical gears from output shaft of transmission.***

When the force exerted on the "third-to-fourth" valve by the governor pressure exceeds that exerted on the opposite end by the throttle-valve pressure and the spring pressure combined, the valve shifts, and oil is allowed to pass to the front-unit clutch pistons and the brake-release piston of the front-unit servo. This shift to fourth gear occurs at about 20 m.p.h. at light throttle. If the accelerator pedal is depressed further, the throttle-valve pressure is increased, consequently the governor pressure must be raised to a higher value before the shift can take place. This can be accomplished only by raising the car speed. Therefore, by varying the throttle opening, the speed at which the shift from third to fourth occurs can be varied within a wide range. At full-open throttle the shift is made at approximately 65 m.p.h.

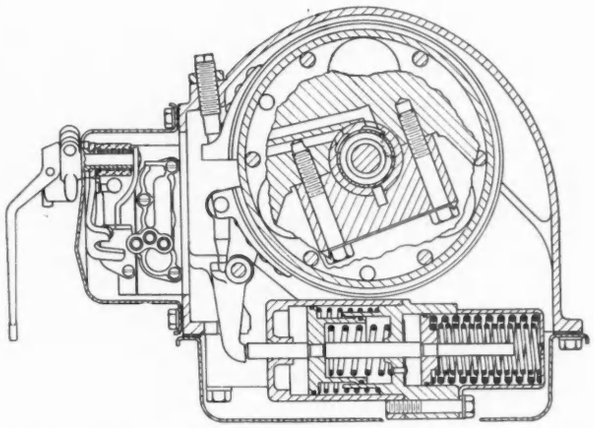


***Fig. 4—Transverse section through transmission showing, at bottom, one of the servo cylinders applying the brake bands.***

To shift down from fourth to third at speeds below 60 m.p.h., it is necessary that the force due to throttle-valve pressure and spring pressure combined exceed the pressure due to the governor. Under these conditions oil pressure is cut off from the clutch pistons and brake release piston, and directed to the brake-applying piston. Opening the throttle wide provides the necessary force on the shifting valve to accomplish this change from fourth to third at speeds between 20 and 60 m.p.h.

The foregoing explanation of how the shift from third to fourth gear occurs is applicable in a general way to all of the forward shifts possible. However, it is not possible to make all down shifts as described, because of certain restrictions placed in the device. In passing, it should be noted that the governor really consists of two valves, of which one builds up pressure very rapidly, while the other builds it up more slowly. This results in greater flexibility of control than is possible with a single-stage governor. In the sketch of the control mechanism only a single valve is shown, for the sake of simplicity. Shifts between first and second gear are actuated by that stage of the governor in which the rate of pressure build-up is more rapid; shifts between second and third and third and fourth make use of both stages.

Although the fluid coupling is quite similar to others which have been used for automobile drives in the past, this device is applied differently in the Oldsmobile Hydra-Matic, with the result that the creep of the car with the engine idling is eliminated, and that the slip and consequent power loss in the coupling in direct drive also are reduced.

The reduction in the creeping tendency may be explained as follows: When the car is at a standstill, with the shift lever in driving position and the engine idling, the transmission is in first gear, and the only reason the car is not moving (if the brake is released) is that the fluid coupling at the low speed of the engine does not produce sufficient torque to set the car in motion. The torque transmitted by the fluid coupling of the Hydra-Matic drive is very low, because with the transmission in first gear the impeller of the coupling turns at only about 0.7 times crankshaft speed, and as the torque transmitted by a fluid coupling varies as the square of the speed, it is only about one half what it would be if the coupling were driven directly from the crankshaft.

Excessive slip in direct drive is avoided because in third and fourth gears the fluid coupling transmits only a fraction of the full torque (approximately 40 per cent), and as the slip varies with the torque, it is naturally much lower than where the coupling transmits all of the torque. It is claimed to be less than 1 per cent over a large part of the driving range.

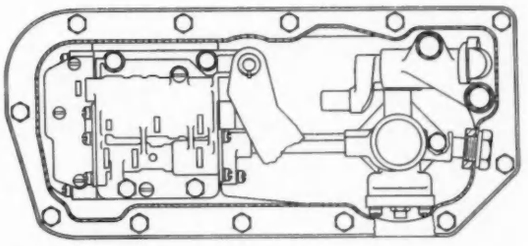


***Fig. 5—Control mechanism in sump of transmission housing.***

An important advantage of the fluid coupling in the transmission is that it will even out torsional disturbances, and it is said to give a softness of feel not possible with a purely mechanical drive.

The transmission elements differ in several respects from the corresponding elements of the former Oldsmobile automatic transmission. In the first place, the front-unit brake band is now applied by oil pressure, instead of by spring pressure. The rear-unit band is

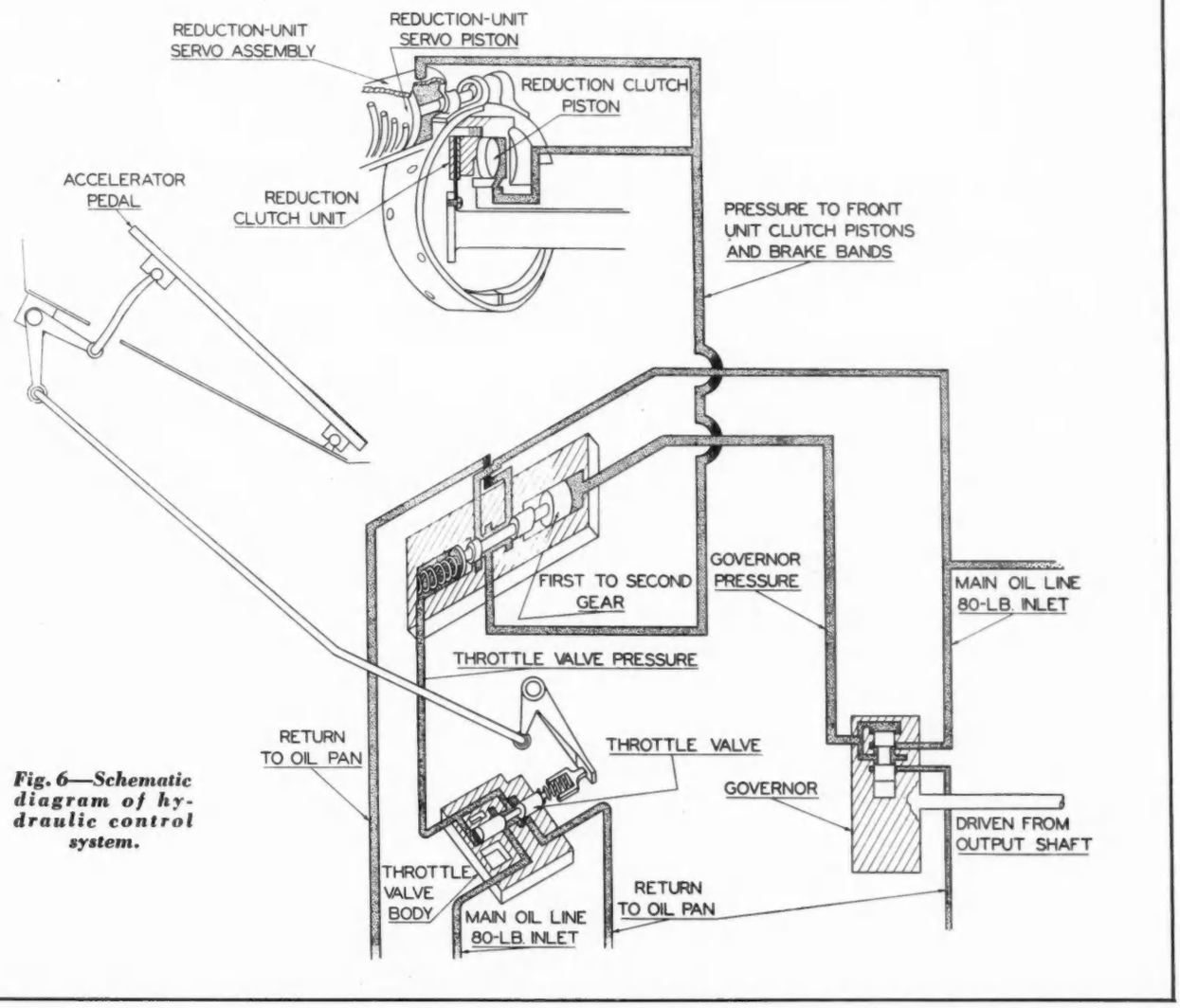



***Fig. 6—Schematic diagram of hydraulic control system.***

actuated by a combination of spring and oil pressure. It is applied and held by spring and oil pressure and released by oil pressure. In the clutch mechanism there are now six pistons, instead of the former three. Band adjustment is external, as before, by means of two adjusting screws extending through the case.

Another innovation is the use of a hydraulic governor driven off the output shaft of the transmission. It consists of two balanced plungers moving outwardly from the axis of rotation under the influence of centrifugal force. One, the high-speed plunger, is provided with a relatively light weight at its end, and produces a slowly-rising pressure curve which reaches its maximum at high speed; the other, a more heavily loaded plunger produces a rapidly rising curve which results in changes of gear at lower speeds. The plungers are arranged to operate the hydraulic-valve control system, as already explained.

# Balanced after Assembly

(*Continued from page* 525)

a screen. The light is reflected from a vibrating mirror to a rotating mirror, and then focused so that an image of the vibration wave is shown on a translucent screen.

The vibration indicator is mounted at the side of the test fixture, so that a pointer, serving as a vibration pick-up, rests against the engine being tested near the left rear mounting boss. The indicator is driven by a synchronous motor which is connected to the larger motor used to drive the engine. In this manner the light beam is synchronized and brought into phase with flywheel rotation. Both the amplitude of the vibration and the flywheel angle at which the amplitude is a maximum can be easily determined from the translucent screen on the indicator. In this manner the amount and the location of the out-of-balance are quickly and accurately determined.

Unit No. 3 is an electric drill which is mounted on the test stand in such a manner as to drill the flywheel at the correct location (flywheel degrees), as determined by the vibration indicator. The depth of drilling is determined by the amplitude of the vibration wave as shown on the indicator screen. The accuracy of this operation is controlled by the skill of the operator in reading the vibration indicator and determining where and how deep to drill. Engines are balanced to within ⅜ oz.-in., which is equivalent of the weight of a dime placed at the flywheel rim.

Following is the procedure in checking an assembled engine for unbalance on this machine:

(1) Install pilot-fixture shaft in clutch and remove engine from production line.

(2) Set engine in test fixture.

(3) Connect coupling between engine and drive motor.

(4) Center clutch mechanism—particularly clutch disk between pressure plate and flywheel.

(5) Connect oil-pressure gage to side of crankcase and plug vacuum pipe leading to combination fuel and vacuum pump.

(6) Check engine for out-of-balance. Engine is run at desired speed by pressing control button and adjusting rheostat. Engine unbalance is indicated on screen.

(7) Stop engine and rotate crankshaft by turning handwheel on power unit until desired flywheel degree is opposite drilling unit.

(8) Feed drill into flywheel rim by turning handwheel; scale on rim indicates depth of drilling.

(9) Start test motor for recheck. When engine balance is within specified limit of ⅜ oz.-in. the light beam wave will fall between two vertical spaces on the indicator scale chart. If engine balance does not check satisfactorily, the operations are repeated until balance is within the desired limit.

(10) Engine is removed from test fixture after balancing, and the clutch-pilot-fixture shaft is removed. The oil pressure gage is removed from the side of the crankcase. During the test the engine oil pump furnishes normal oil pressure for the protection of all moving parts. The lower flywheel pan is installed and the engine is then returned to the conveyor line.

## Determining Specific Heats of Gases of High Temperatures

A NOVEL method of determining the specific heats of gases of high temperatures (which are of importance in thermodynamic calculations) is being employed by the British National Physical Laboratory. It has been found that the specific heat of argon is substantially constant up to 5000 deg. Fahr., and this permits of determining the "argon equivalents" of such constituents of the products of combustion as carbon monoxide, carbon dioxide, and nitrogen. Values for these specific heats have been obtained by means of a series of "matched" explosions in a bomb calorimeter. Conditions under which the explosions occurred were so adjusted that the time and temperature of the explosion and the percentage of heat loss during a short period following the explosion were substantially the same in all cases. This eliminates the difficult process of direct measurement of the heat loss during the explosion, and, therefore, should give rather accurate results. The values obtained are said to agree within 1 per cent with those obtained by the band-spectra method which has been used in this country for the same purpose.

# New Brake Design

***Quicker stopping, rapid cooling of drum, easy replacement of lining and economy are claimed***

A STRIKING innovation in brake design is revealed in the equipment being produced by the Detroit Due-Grip Brake Co., Detroit, Mich. The illustration shows a typical layout of the brake system for application as a propeller shaft brake. It is designed not only for parking but for regular braking to supplement the service brake system of the vehicle. The latest development is the adaptation of the principle illustrated to a complete four-wheel brake system, actuated mechanically, hydraulically, or pneumatically.

As is evident from the drawing, the Duo-Grip brake consists essentially of two segmental brake shoes, one contacting the inner, the other the outer surface of the drug, both being actuated by forks adjustable for wear. When the brake is applied, the inner and outer shoes are drawn together and grip the drum on both the inner and outer periphery. When the brake lever is released, both shoes are released and permit the drum to rotate freely.

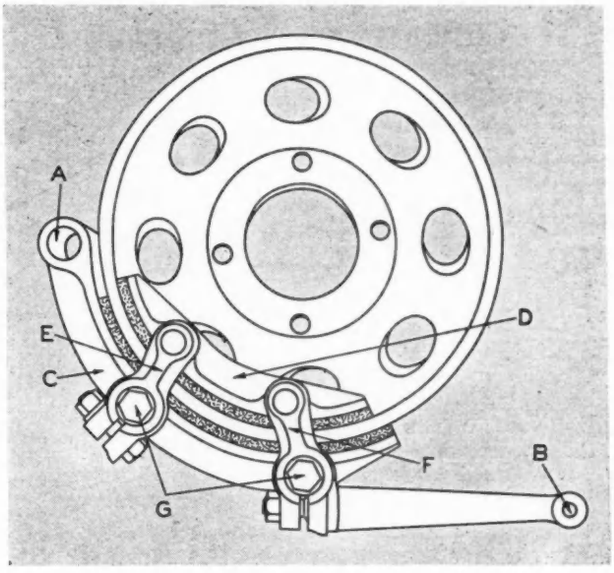
Two outstanding advantages, both of interest to engineers and operators alike, are claimed for this brake. The first is greatly increased lining life and smoother brake application, due to rapid dissipation of heat. It is pointed out that more than two-thirds of the drum surface is exposed, and that the entire system is pressure-cooled by the impeller action of slotted holes drilled through the web of the drum. As a result of this cooling effect, it is claimed that lining life is increased, drum scoring eliminated, and increased applications without fading are guaranteed.

The second advantage is quick replacement, in the event of excessive lining wear or road failure. This is accomplished by the use of interchangeable shoes which can be installed in about 20 min., even on the road, according to the manufacturer. The entire replacement operation consists of the following steps—remove nut A at the anchor pin of the outer shoe, remove clevis pin at B, and then slide out the entire shoe assembly. Remove the shoes from forks E and F, and assemble the forks to the replacement shoes. Install by reversing the former procedure and adjust by means of eccentric studs at G.

The brake is available also in another style with non-adjustable forks, in which the adjustment is made in the linkage to the lever B.

The following features are claimed by the manufacturer:

1. Quicker stopping through greater braking capacity.




2. Quicker and easier replacement of linings.
3. Longer life of linings.
4. Insures positive hold against roll-back on any grade.
5. Quick, easy and positive adjustment by eccentric studs.
6. Rapid cooling by ventilated drum.
7. Two-thirds of drum exposed to air, permitting rapid dissipation of heat.
8. Not affected by "growing" brake drum.
9. Braking not affected by out-of-round brake drum.
10. Lower cost of linings.

The Due-Grip brake has been tested by a number of important truck manufacturers, and one of the largest has adopted the system as standard equipment.

## Acetyl Cellulose Plastic Substitute for Metals

The manufacture of "Somite," an acetyl cellulose plastic substitute for metals, will soon be undertaken on an industrial basis in Japan.

"Somite," according to a report received at the Department of Commerce, is made of waste fiber by the viscose process and is claimed to combine the plasticity of synthetic resin, the ductility of celluloid, and the strength of vulcanized rubber. It is reported to be insoluble at high temperatures and little affected by acetone, benzine, oil and other hydro-phobe materials.

## FOREWORD

THE method adopted by the authors in analyzing engine combustion consists in treating separately the two simultaneous phenomena, burning and expanding of the reaction zone. Small volume increments burn at constant volume, then expand into both the previously-burned and the still-unburned portion of the mixture, until pressure equilibrium is reached. As the reaction progresses, each increment burns under different conditions of pressure, temperature, and chamber volume. The time elapsed for a given linear flame displacement in space is determined by the reaction velocity—the linear rate at which the flame travels *with respect to the unburned gas.* After deriving the relations between flame velocity and reaction velocity, a method for predetermining pressure-time characteristics of a chamber design is presented. Pressure and flame records obtained in various types of combustion chambers and under various operating conditions are analyzed to show the effect upon the reaction velocity of such variables as mixture ratio and induction and compression turbulence, these latter in turn being controlled by the engine speed, piston movement, chamber contour, and spark advance. Other factors studied are the throttle opening, temperature of the unburned mixture, local hot spots in the chamber, such as the exhaust valve; random turbulence induced by elements of the chamber contour such as the end wall at clearance space and its sharp corners, and the effect of the chamber walls upon mass movement of the unburned gases and consequent induced flame turbulence.

It is shown that the duration of the entire combustion cycle, depending mainly on the reaction velocity, controls the peak pressure and also detonation. Consequently, for given fuel-air mixtures there is a definite relation between the maximum pressure that can be obtained without detonation, and the corresponding time elapsed from ignition.

From the experimental results it appears that the initial stage of combustion is the most sensitive to the effects of the various factors governing the reaction velocity. Consequently, it is the logical point of attack for future efforts in producing a more stable and faster burning mixture (less stratification and more turbulence) in the vicinity of the spark plug at the instant of ignition.

The ignition system should be improved so that it will handle satisfactorily, mixtures of a wide range of inflammability.

# Gasoline

By HECTOR RABEZZANA, STEPHEN KALMAR and ALFRED CANDELISE*

MOST of the early fundamental work on engine combustion was based upon results of experiments with closed bombs. In applying these findings to the engine, it was often overlooked that the volume of the bomb remains constant during the explosion, while in the engine the combustion-chamber volume changes continuously; that in most of the cases, spherical bombs are ignited at the center, while in the engine this is very seldom so; that the mixture in bombs is generally in a stagnant state, while in engines it is in a state of high turbulence. Pressure in the bomb is due to combustion only, in the engine it is affected by the moving piston. Flame propagation in a spherical bomb fired at the center is spherical, in the engine it is modified by the chamber contour. Reaction velocity in a bomb is much lower than in an engine.

Due to these inherent differences, attempts to predetermine pressure-time characteristics of engine chambers analytically by methods based on bomb results did not meet with great success.

With the development of new instrumentation (see reference list 1, 2, 3, 4, 5, 6, 7) pressure development and flame movement in engines were recorded simultaneously, and the effects of some variables on both determined. By eliminating the effect of piston movement on pressure (8, 9), the relation between pressure rise due to combustion or fractional-mass burned and volume swept by the flame was established. Fig. 1 shows a comparison of mass-volume relations obtained analytically by several investigators and by the authors (9, 10, 11, 12, 13). While the correlation of pressure rise and burned volume yields valuable information for interpreting and coordinating the effect of variables on

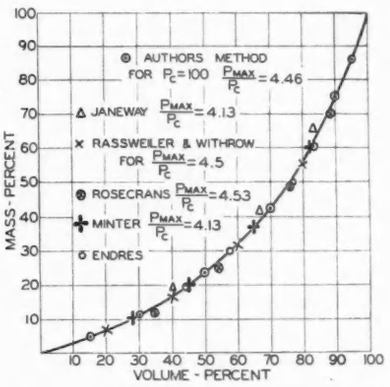



***Fig. 1—Relation between mass and volume of the burned charge, determined analytically by several investigators. Although, the assumptions and the methods were different, in each case, the results show remarkable agreement.***

* All of the co-authors are of the AC Spark Plug Division, General Motors Corp., Flint, Mich.

**Part One** *Part two will appear in an early issue*

# Engine Combustion

pressure development and flame propagation, it has—for the engine designer at least—only a purely academic value; the most important element, time, is missing.

To connect pressure development and flame propagation with time, the reaction velocity must be known. Unfortunately, flame speed records in a closed vessel do not directly represent reaction rates, as the flame propagation is due to burning and expanding. Reaction rates obtained with stagnant mixtures cannot be applied to engine explosions.

A rigid theoretical treatment of the combustion mechanism, including all the variables inherent in the engine, is difficult if not impossible. Should such a solution be found, its practical application would be rather tedious.

By omitting or simplifying scientific refinements, it is possible to reduce the mechanism to its essentials without distorting the fundamental principles; by disregarding details, clarity is gained and, above all, results which may be applied practically are obtained.

In the following, the authors attempt to interpret the gross mechanism of engine combustion. Based upon experimental data correlated with fundamental thermodynamics, this mechanism explains many of the phenomena known to all familiar with this subject, and it may prove a useful tool in the hands of the engineer.

*Fig. 2—Film-drum housing, with neon tubes built in, used to take flame records simultaneously with pressure indicator card.*

## Experimental Apparatus and Procedure

The test apparatus used consisted of the single-cylinder engine and test equipment described in a previous paper (8) but refined and modified; in addition, several multi-cylinder engines of recent design, suitably equipped for recording flame travel and pressure development were used.

1—Pressure Time Records were obtained with the Martin-Caris carbon-stack indicator of the latest design (water-cooled diaphragm, temperature-compensated carbon stack) by means of a three-element oscillograph.

To coordinate pressure development and flame travel, single-cycle records were used; to establish p-t characteristics of chamber designs or to determine the effect of variables upon reaction velocity, 30 to 40 cycle cards were averaged.

2—Flame Records were obtained by means of the ionization gap method outlined in the above-mentioned paper. To coordinate the simultaneous flame propagation and pressure rise of a single cycle, the neon tubes signaling the arrival of the flame at the corresponding ionization gap were built directly into the oscillograph drum housing containing the rotating film upon which the pressures were recorded, so that p-t and flame records of the same single explosion were obtained simultaneously. Fig. 2 shows a drum housing containing 12 neon tubes, arranged in a fixed pattern; one of the tubes was actuated by capacitative coupling from the secondary ignition lead, the other 11, through individual amplifier units, were controlled by 11 ionization gaps located in key positions in the chamber. The flash of the neon tubes was recorded by images on the film. Knowing the relative location of the tubes (still pattern), the time elapsed from ignition to the arrival of the flame at each of the 11 ionization gaps in the chamber was found by superimposing the still pattern on the flame record in such manner as to make the flash record of ignition coincide with the corresponding flash line in the still pattern and then measuring the distance from each of the flash records to the corresponding flash line on the still pattern. Time markings on the film provided by a top-dead-center indicator supplied the conversion factor into degrees crank angle, and the break of the primary ignition current, also recorded on the film, provided a check on the spark advance.

Fig. 3 shows schematically a combined p-t and flame

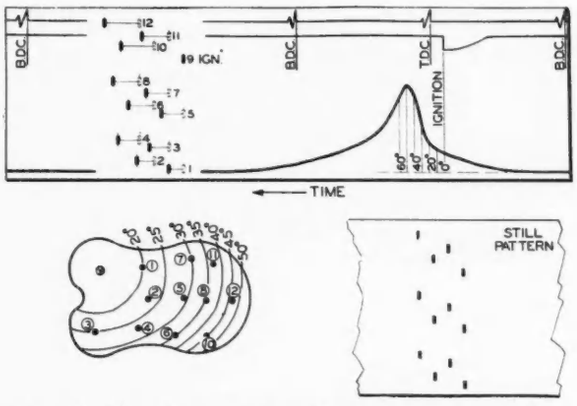



***Fig. 3—Simultaneous record of pressure and flame (top), the resulting flame pattern (bottom left), and the still pattern showing location of flash tubes.***

record of a single cycle. Ignition was recorded by flash tube 9.

With averaged pressure cards, average flame records were obtained. The ionization gaps, which varied in number from 9 to 34 in one chamber, were, one after the other, connected through an amplifier to a neon flash tube installed in a disc rotating on the front end of the crankshaft, and the time of the arrival of the flame at the corresponding ionization gap was read directly in degrees on a protractor. In accordance with the cycle-to-cycle variation of the flame pattern, there was, of course, a variation in the protractor reading for each gap; by carefully observing the wandering of the flash, the average value was determined. In Fig. 4 the three flame records and pressure-time curves marked A, B and C show the range of variation observed during stabilized full-load operation. For comparison, the averaged flame pattern and pressure-time curve is also shown. In the plot at the lower right, the averaged protractor readings (dashes) are compared to values obtained from cycle records (dots).

For the ionization gaps in the combustion chamber, small (6 mm.) spark plugs were used. These were screwed directly into the roof of the chamber. A rubber hose was then cemented over the upper part of the plug insulator to seal it from the cooling water. The hose was taken through a hole in the water jacket roof and sealed with litharge to prevent water leakage. The number of gaps was limited to 34 in a chamber of average size. Fig. 5 shows photographs of a single-cylinder chamber and a multi-cylinder chamber provided with ionization gaps.

3—Borderline Detonation. Incipient detonation in the cylinder under test was determined from indicator cards, by observing closely the pressure curve at peak. It was found that the pressure curve showed a slight kink around the peak, indicating a sudden pressure rise due to knock, when the human ear could not always detect the "ping," or when several observers could not always agree as to the "border-line" setting. Therefore, to eliminate the human element, "borderline" was determined from pressure records.

## The Process of Combustion

The process of combustion outlined in this study is based upon the assumption that reaction and energy liberation occur in a narrow active zone, the "reaction zone." This has been observed by chemical, photographical and spectrographical experiments. (1, 9, 14.) The linear speed of the flame front with respect to the unburned gases is the "reaction velocity." Due to the expansion of the burning gas, the unburned portion itself is moving ahead of the flame front ("gas velocity"), consequently, the recorded speed of the flame is the combination of the reaction velocity and the gas velocity; this linear rate of travel of the flame in space, or with respect to fixed coordinates of the chamber, is the "flame velocity."

At the start, flame travel is due mainly to the mass movement caused by expansion of the burning zone, which takes place almost entirely in the direction of the unburned portion; consequently the main component of the flame velocity is the gas velocity. At the end of the explosion, when the flame reaches the end of the chamber, the expansion occurs mainly in the direction of the burned portion, and, therefore, the flame velocity consists mainly of the reaction velocity.

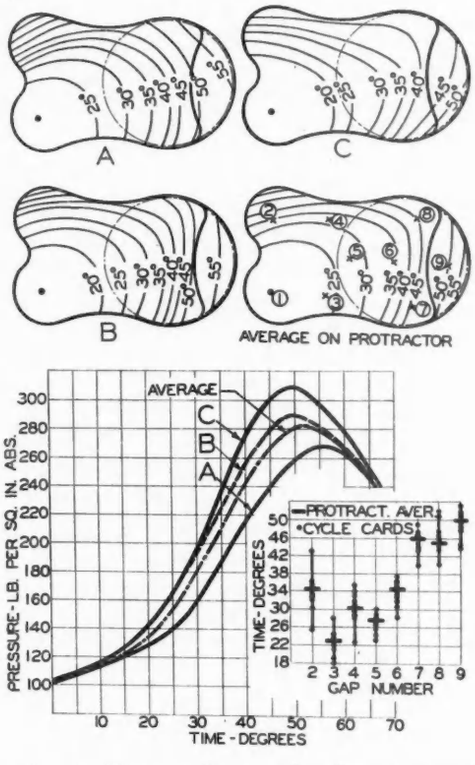



***Fig. 4—Three cycle records of pressure and flame (A,B,C,) showing range of variation, compared to average pressure curve and flame diagram.***

Complex phenomena which cannot be treated analytically, can be interpreted by step-by-step methods; such an approach has been applied to the explosion in an engine by assuming that combustion occurs in separate volume increments, and by separating the simultaneously occurring phenomena in each increment.

The method employed in the following analysis consists, briefly, in burning a volume increment at constant volume and expanding the same into the already-

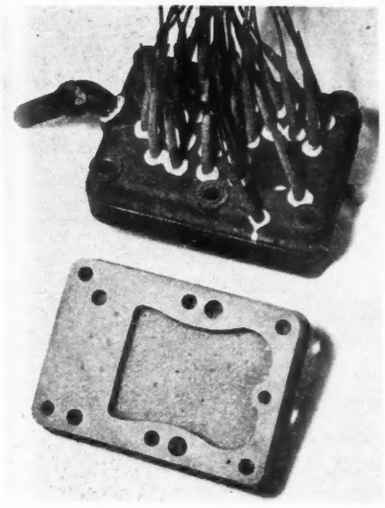
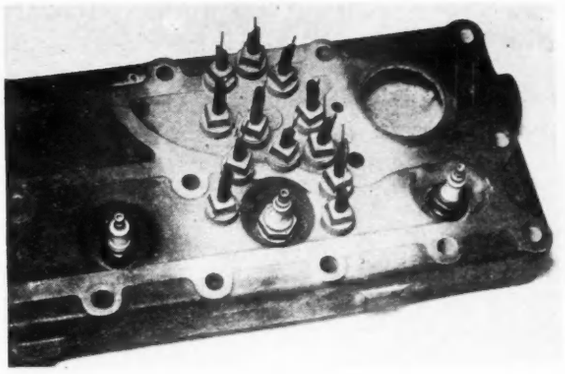
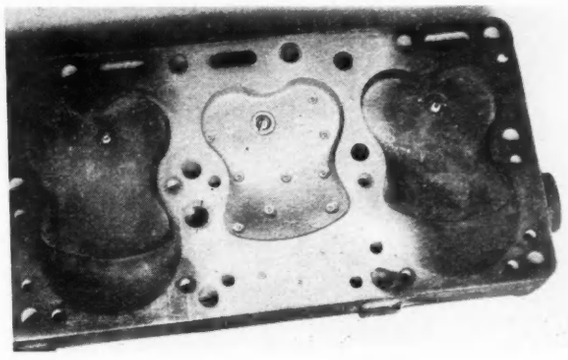


*Fig. 5 — Single-cylinder and multi-cylinder combustion chambers provided with ionizated gaps for recording flame propagation.*





burned and still-unburned portion of the mixture, until pressure equilibrium is reached.

Referring to the closed vessel shown schematically in Fig. 6 *a*, let us assume that line *F* marks the separation between the burned and unburned gases after the combustion has progressed to a certain extent. The pressure $P_o$ in the whole chamber is uniform.

1—COMBUSTION PRESSURE. As the reaction proceeds along line *F*, let us consider a volume element $v_b$ (Fig. 6 *b*) which burns at constant volume.

The general equation for a transformation at constant volume is

$$\frac{P_1}{P_o} = \frac{R_1 T_1}{R_o T_o}$$

The heat $Q$ added, due to combustion, will cause a temperature increase of $\Delta T = Q/c_v$, which is constant for a given mixture. The pressure, after the completed reaction in $v_b$, will be

$$P_1 = P_o \frac{R_1}{R_o} \frac{T_0 + \Delta T}{T_o}$$

Assuming that for an air-gasoline mixture of 13 to 1, $\Delta T = 2270$ deg. C., and using the relationship

$$\frac{R_1}{R_o} = \frac{1}{0.926}$$

we have

$$P_1 = \frac{P_o}{0.926}\left(1 + \frac{2270}{T_o}\right) \quad \ldots\ldots \quad (1)$$

The relation between $P_o$, $T_o$ at the start of the reaction of $v_b$ and the initial conditions $P_i$, $T_i$ at the closing of the intake valve is expressed as follows:

$$T_o = T_i \left(\frac{P_o}{P_i}\right)^{\frac{n-1}{n}}$$

For full-load conditions, with

$P_i = 14.7$ lb. per sq. in. abs., $T_i = 350$ deg. C. abs.

and $n = 1.35$, equation (1) becomes

$$P_1 = \frac{P_o}{0.926}\left(1 + \frac{13.05}{P_o^{0.26}}\right) \quad \ldots\ldots \quad (2)$$

The ratio

$$\frac{P_1}{P_o} = Y \quad \ldots\ldots\ldots \quad (3)$$

is plotted as a function of $P_o$, in Fig. 7, Plot *A*.

2—THE EQUILIBRIUM PRESSURE AFTER EXPANSION. Since $P_1$ is higher than $P_o$, which is the pressure in the rest of the chamber, volume $v_b$ will expand until equilibrium is reached at a pressure $P$. The expanded volume $V_E$ (Fig. 6*c*) of the original element $v_b$ is determined as follows: It is assumed that the polytropic exponent $n$ is the same for the burning, burned and unburned portions.

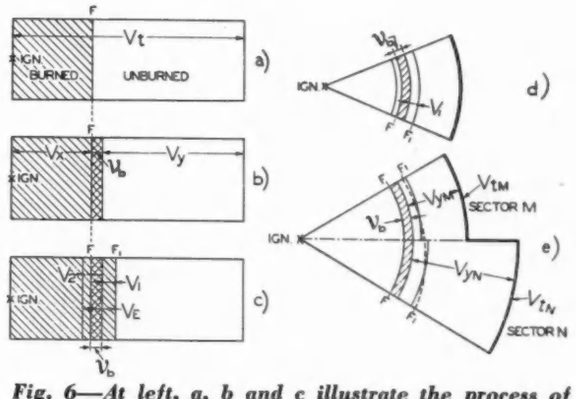



*Fig. 6—At left, a, b and c illustrate the process of combustion; at right, d and e show the principle of flame-front distortion.*

For the expansion of the burning element $v_b$, we have:

$$P_1 v_b^n = P V_E^n \quad \ldots\ldots\ldots \quad (4)$$

The rest of the chamber volume $V_t - v_b$ is compressed at the same time

$$P_o(V_t - v_b)^n = P(V_t - V_E)^n \quad \ldots\ldots \quad (5)$$

Combining equations (3), (4) and (5) we obtain

$$V_E = \frac{V_t Y^{\frac{1}{n}}}{\frac{V_t}{v_b} + Y^{\frac{1}{n}} - 1} \quad \ldots\ldots\ldots \quad (6)$$

and the final pressure of equilibrium

$$P = P_o \left[ \frac{v_b}{V_t} (Y^{\frac{1}{n}} - 1) + 1 \right]^n \quad \ldots\ldots \quad (7)$$

The values of the factor

$$\left[ \frac{v_b}{V_t} (Y^{\frac{1}{n}} - 1) + 1 \right]^n = K_b$$

and of $V_E$, both as a function of $P_o$ and $V_t$, and for an increment $v_b = 0.5$ cu. in. are plotted in Fig. 7, Plots $C$ and $B$.

3—Location of Flame Front After Expansion. In order to determine the location $F_1$ of the flame front after $v_b$ has burned and expanded, we proceed as follows:

Referring to Fig 6 *b* and *c*,

$$P_o V_x^n = P(V_x - V_2)^n$$

determines the compression of the previously-burned gas volume $V_x$, and

$$P_o V_y^n = P(V_y - V_1)^n$$

the compression of the unburned volume $V_y$.

Dividing the two equations, we have

$$\frac{V_2}{V_1} = \frac{V_x}{V_y} \text{ ; but } V_E = V_1 + V_2 + v_b \text{ , hence}$$

$$V_1 = V_y \frac{V_E - v_b}{V_t - v_b} \quad \ldots\ldots\ldots \quad (8)$$

4—Time. The volume $V_t$ is the amount of expansion into the unburned gas. The linear displacement $L$ of the flame from $F$ to $F_1$ is

$$L = \frac{v_b + V_1}{A} ,$$

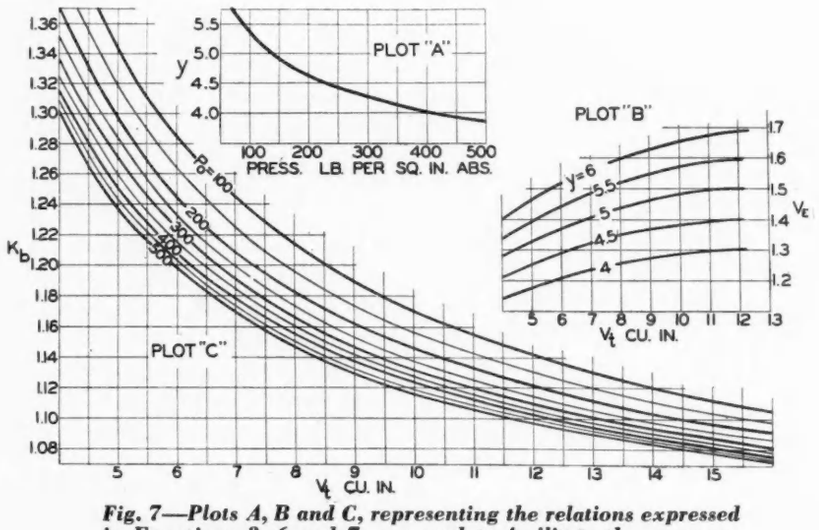



*Fig. 7—Plots A, B and C, representing the relations expressed in Equations 3, 6 and 7, are used to facilitate the pressure-time analysis.*

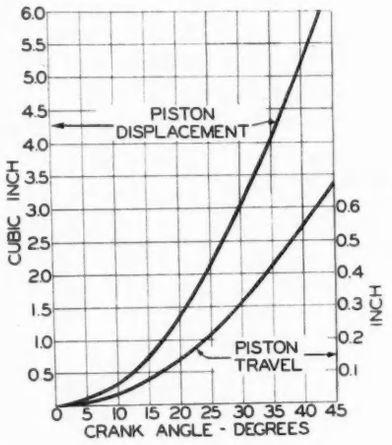



*Fig. 8 — Piston travel and displacement curve used in the analysis.*

where $A$ is the flame-front area.

Of this displacement $v_b/A = l$ is due to burning, while $v_1/A = l_1$ is due to expanding. For normal combustion both burning and expanding can be assumed to occur simultaneously, and the time elapsed while the flame travels a distance $L$ is determined by the linear reaction velocity $S_r$:

$$\text{Time} = \frac{\quad}{S_r}$$

Using, as an illustration, the familiar analogy of a man on a moving train, walking in the direction of travel, the distance on the train covered by the man during a certain time corresponds to $l$, his speed to $S_r$; during the same time the train itself moved a distance corresponding to $l_1$, so that the total distance traveled by the man, in space, is $l + l_1 = L$, and the time elapsed is $l/S_r$.

5—The Shape of the Flame Front. The location of the new flame front $F_1$ depends on the chamber contour. The method involved is illustrated in Fig. 6 *d* and *e*. Assuming a chamber of uniform height, if the chamber wall ahead of the burning element $v_b$ is at a uniform distance from $F$ along its entire length, $F_1$ will be located at a uniform distance of $V_1/A$ from the burning element $v_b$ (See Fig. 6 *d*). If, on the other hand, the wall ahead of the element $v_b$ is not equidistant, as, for instance, in the chamber shown in Fig. 6 *e*, composed of two sectors $M$ and $N$, the total expanded volume $V_1$ in the direction of the unburned gas obtained by equation (8) will be proportioned unequally between the two sectors. By dividing $V_1$ in proportion to the volume in each sector ahead of the burning element, $V_{yM}$ and $V_{yN}$, and in inverse proportion to the total volume of each sector, $V_{tM}$ and $V_{tN}$ good agreement with observed flame records is obtained. The final location of $F_1$ is then obtained by averaging the individual flame fronts in each sector (dashed line). By interpreting the flame front distortion in ac-

cordance with this principle, it is at once clear that in a closed vessel which is not symmetrical with respect to the ignition point, the flame front is not spherical but is distorted in relation to the chamber wall contour and the volume ahead and behind the flame front.

6—EFFECT OF PISTON MOVEMENT.—Due to piston movement, the chamber volume is constantly changing during an explosion, affecting the expanded volume (equation 6), equilibrium pressure (equation 7), and flame-front displacement (equation 8) of the burning element. Applying the step-by-step method, we may either let the element $v_b$ burn and expand with the piston at rest and move the piston after equilibrium pressure is reached, or let the piston move first and burn and expand afterwards. A rigorous treatment of the problem indicates that the results obtained by the two methods differ very little, if the volume increments are small. In the following, the first method was used; that is, burning and expanding with the piston stationary at a volume $V_{to}$, and then correcting the equilibrium pressure $P$ for the effects of piston movement which changed the volume from $V_{to}$ to $V_t$, using the general equation: $PV^n = \text{const.}$

The corrected pressure

$$P_t = \frac{P}{\left(\frac{V_t}{V_{to}}\right)^{1.35}} \quad \text{and making} \quad \frac{V_t}{V_{to}} = V_r,$$

we get

$$P_t = \frac{P}{V_r^{1.35}}$$

For convenience, piston travel and piston displacement vs. crank angle are plotted in Fig. 8.

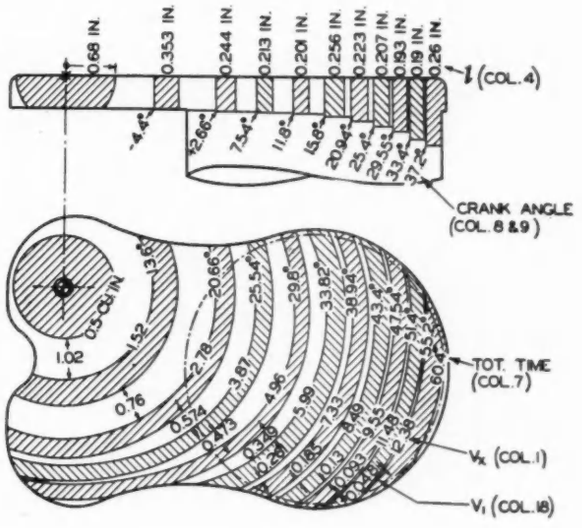
## *Application of Method*

To illustrate the method discussed in the foregoing, the calculations of flame travel and pressure development in the combustion chamber shown schematically in Fig. 9 are given in tabular form in Fig. 10. Engine data: 3½-in. bore, 4-in. stroke; compression ratio, 5.65 to 1; speed, 1500 r.p.m.; spark advance, 18 deg.; throttle, wide open; fuel, gasoline; maximum-power air-fuel ratio.

All calculations refer to a volume increment of 0.5 cu. in. It is assumed, for the time being, that the reaction velocity is constant and equal to 0.05 in. per deg. or 11.4 meters per second.

Each increment is considered as burning at constant volume and then expanding into a chamber determined by the initial conditions of the increment considered.

For the first increment we draw a spherical surface centered at the ignition point and enclosing a volume of 0.5 cu. in.; the radius of this spherical element, $l = 0.68$ in., represents the time or 13.6 deg. (Col. 1 to 7). The initial conditions of this first increment are known because they are determined by the spark advance (18 deg.), which fixes the total volume of the chamber at ignition, and the initial pressure. Varia-




*Figs. 9 and 10 (Table below)—Illustration of the step-by-step method of analyzing the combustion process.*

| Increment Number | COMBUSTION TIME | | | | | | | VOL. CHANGE DUE TO PISTON MOV. | | | | | | EXPANSION VOLUME | | | | | | Combustion Pressure | | Pressure Correction for Piston Movement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Burned Volume at Start | Volume Increment to Burn | Flame Front Area (Sq. In.) | Travel (In.) | Reaction Vel. (In./Deg.) | Time for Increment (Deg.) | Total Time (Deg.) | Piston Position Deg. CR. A. | | Displaced Volume (Plot "D") | | Total Chamber Volume | | Pressure at Start | Pressure Ratio (Plot "A") | Exp. Vol. for $V_{to}$ (Plot "B") | Vol. Ahead of Burning Increment | Exp. Vol. in Unburned Portion | Burned Vol. at End of Increment | Pressure Factor for $P_o - V_{to}$ (Plot "C") | Pressure at End of Comb. | Volume Ratio | | Final Pressure at End of Increment |
| | | | | | | | | Start | End | Start | End | Start | End | | | | | | | | | | | |
| | $V_x$ | $V_b$ | A | $l=\frac{V_b}{A}$ | $S_r$ | $\frac{l}{S_r}$ | $\Sigma\frac{l}{S_r}$ | | | $V_{po}$ | $V_p$ | $V_{to}$ | $V_t$ | $P_o$ | Y | $V_E$ | $V_y$ | $V_1$ | $V_x{}^1$ | $K_b$ | $P = P_o \times K_b$ | $V_r = V_t/V_{to}$ | $V_r{}^{1.35}$ | $P_t = P/V_r{}^{1.35}$ |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 1 | | .5 | | .680 | .05 | 13.60 | 13.60 | 18° | −4.40 | 1.10 | .08 | 9.40 | 8.38 | 105.0 | 5.27 | 1.520 | 8.900 | 1.020 | 1.52 | 1.179 | 123.8 | .892 | .856 | 144.5 |
| 2 | 1.52 | .5 | 1.415 | .353 | .05 | 7.06 | 20.66 | −4.40 | +2.66 | .08 | .04 | 8.38 | 8.34 | 144.5 | 4.97 | 1.440 | 6.360 | .760 | 2.78 | 1.186 | 171.2 | .995 | .993 | 172.5 |
| 3 | 2.78 | .5 | 2.050 | .244 | .05 | 4.88 | 25.54 | +2.66 | 7.54 | .04 | .20 | 8.34 | 8.50 | 172.5 | 4.78 | 1.420 | 5.060 | .574 | 3.87 | 1.182 | 204.0 | 1.020 | 1.026 | 199.0 |
| 4 | 3.87 | .5 | 2.350 | .213 | .05 | 4.26 | 29.80 | 7.54 | 11.80 | .20 | .48 | 8.50 | 8.78 | 199.0 | 4.64 | 1.390 | 4.130 | .473 | 4.96 | 1.172 | 233.5 | 1.033 | 1.045 | 223.0 |
| 5 | 4.96 | .5 | 2.490 | .201 | .05 | 4.02 | 33.82 | 11.80 | 15.80 | .48 | .84 | 8.78 | 9.14 | 223.0 | 4.53 | 1.375 | 3.320 | .349 | 5.99 | 1.161 | 257.0 | 1.040 | 1.055 | 245.0 |
| 6 | 5.99 | .5 | 1.952 | .256 | .05 | 5.12 | 38.94 | 15.80 | 20.94 | .84 | 1.52 | 9.14 | 9.82 | 245.0 | 4.45 | 1.350 | 2.650 | .261 | 7.33 | 1.153 | 282.5 | 1.075 | 1.103 | 256.0 |
| 7 | 7.33 | .5 | 2.240 | .223 | .05 | 4.46 | 43.40 | 20.94 | 25.40 | 1.52 | 2.20 | 9.82 | 10.50 | 256.0 | 4.40 | 1.365 | 1.990 | .185 | 8.49 | 1.140 | 292.0 | 1.070 | 1.096 | 266.0 |
| 8 | 8.49 | .5 | 2.420 | .207 | .05 | 4.14 | 47.54 | 25.40 | 29.55 | 2.20 | 2.90 | 10.50 | 11.20 | 266.0 | 4.35 | 1.360 | 1.510 | .130 | 9.55 | 1.130 | 300.5 | 1.066 | 1.090 | 276.0 |
| 9 | 9.55 | .5 | 2.590 | .193 | .05 | 3.86 | 51.40 | 29.55 | 33.40 | 2.90 | 3.75 | 11.20 | 12.05 | 276.0 | 4.34 | 1.370 | 1.150 | .093 | 11.48 | 1.120 | 309.5 | 1.077 | 1.105 | 280.0 |
| 10 | 11.48 | .5 | 2.630 | .190 | .05 | 3.80 | 55.20 | 33.40 | 37.20 | 3.75 | 4.58 | 12.05 | 12.88 | 280.0 | 4.32 | 1.370 | .064 | .048 | 12.38 | 1.112 | 311.5 | 1.089 | 1.094 | 285.0 |
| 11 | 12.38 | .5 | 1.925 | .260 | .05 | 5.20 | 60.40 | 37.20 | 42.40 | 4.58 | 5.80 | 12.88 | 14.10 | 285.0 | 4.30 | | | | | 1.103 | 314.0 | 1.096 | 1.132 | 278.0 |

tions of the chamber volume due to the motion of the piston during this interval of 13.6 deg. (from Fig. 8) are recorded in Cols. 8 to 13. From the initial pressure $P_o = 105$, with the help of Plot *A* of Fig. 7, we find that $Y = 5.27$; from this value of $Y$ and that of $V_{to}$ (= 9.4), with the help of Plot *B* of Fig. 7, we find that the expanded volume $V_E = 1.52$; from this expanded volume we compute that portion that expands into the unburnt gas, $V_t = 1.02$ (Col. 14 to 19). This volume $V_t$ is then drawn in Fig. 9 following the flame-front pattern built according to the principles explained in Fig. 6.

Columns 20 and 21 record the constant-volume pressure development; the pressure coefficient $K_b$ will be found in Plot C of Fig. 7, where we see that for $V_{to} = 9.4$ and $P_o = 105$, $K_b = 1.179$. The resulting pressure is $P = P_o \times K_b = 123.8$.

This pressure must now be corrected for the effect of the piston movement, which caused the chamber volume to change from $V_{to} = 9.4$ to $V_t = 8.38$ during this increment. The corresponding change in pressure is determined by

$$\left(\frac{V_t}{V_{to}}\right)^{1.35} = V_r^{1.35} = 0.856,$$

so that the final pressure at the end of the increment will be $P_t = 144.5$ (Cols. 22 to 24). The boundary-line enclosing volume $V_t = 1.52$ represents the starting flame-front for the second increment, for which the calculations are made as for the first, with the difference that it is now possible to measure the flame-front area $A = 1.415$ (Col. 3), from which the distance $l$ (= 0.353) is computed. To locate the second increment $v_b$, we draw a line parallel to, and at a distance of 0.353 in. from the line denoting $V_t = 1.52$, the expanded volume of the first increment.

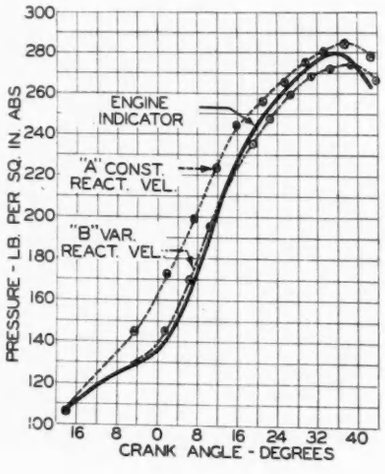
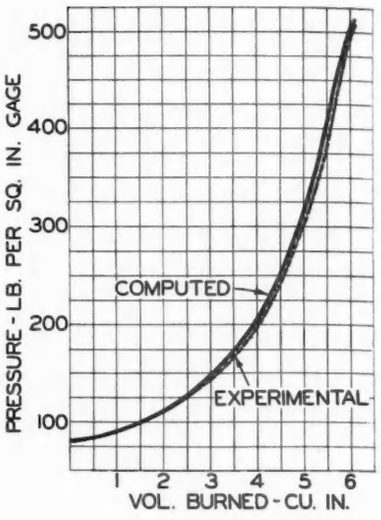



*Fig. 11 — Comparison of computed pressure-time curves with an indicator card.*

Proceeding in the same manner as for the first increment, we continue until the end of the chamber is reached; the peak pressure will be attained when $K_b = V_r^{1.35}$ and this, in the present case, happens between the 10th and 11th increments.

Finally, we plot the pressure $P_t$ (Col. 23) against the time (Col. 8) and we then have the synthetic *p-t* curve (*A*) shown in Fig. 11.

For comparison, a *p-t* indicator diagram, taken under the same conditions of speed and spark advance, is included. The two diagrams do not agree, especially at the beginning. The reason for the disagreement can be either that the pressure-volume relations in the applied analytical method are not correct, or that the value of the reaction velocity, which was assumed to be constant, is not correct or is not constant.




The check on the analytical pressure-volume relation, expressed also by the curve in Fig. 1, can be made better in a bomb than in an engine, because there all doubts resulting from the assumptions made in correcting for the piston effect are eliminated. This was done for the bomb shown schematically in Fig. 12; the results were plotted in Fig. 13 and compared with experimental values obtained from a flame diagram (volume) and an indicator card (pressure). The results agree very closely. Similar agreement was obtained in numerous bomb explosions.

This indicates that the disagreement was due to the selection of a constant reaction velocity.

The calculations of Fig. 10 were then repeated, selecting values for the reaction velocity for each increment (Col. 5) which would give the same flame front pattern with respect to time as the flame diagram in Fig. 14 recorded simultaneously with the pressure indicator card presented in Fig. 11; the calculations are analogous to those in Fig. 10; the resulting pressure-time curve (Fig. 11 B) shows a close agreement with the indicator card.

This points to the conclusion that the reaction velocity is not constant, but varies during the combustion process.

Before the method outlined above can be used for predetermining p-t characteristics of a chamber de-

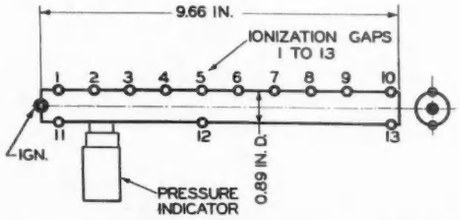


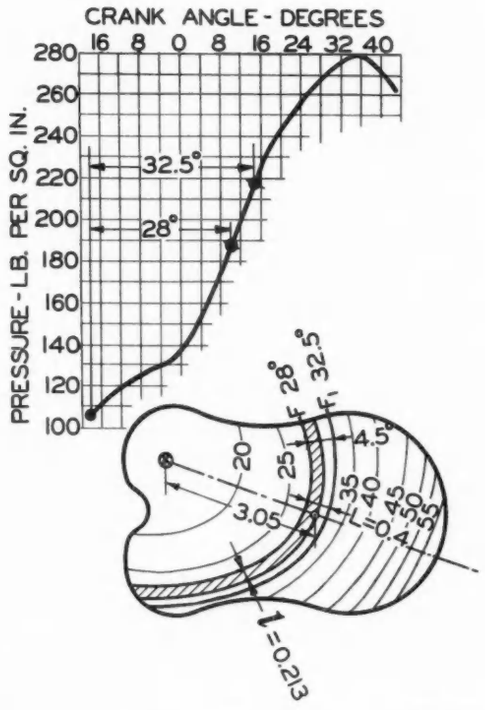

*Fig. 12 — Schematic view of explosion bomb, showing location of ionized gaps.*

sign, the values of the reaction velocity have to be known.

Unfortunately, the reaction velocity of a mixture depends on the specific conditions of the reaction itself, and, consequently, results obtained under laboratory conditions (Bunsen, bomb, etc.), cannot be applied to engine conditions. Furthermore, even if for a given set of conditions in the engine the reaction velocity at ignition were known, the effects of numerous variables to be discussed later would cause it to vary during the combustion process.

Hopeless as it seems to establish *a priori* the behavior of the reaction velocity for every case, it is possible to evaluate it from p-t curves and corresponding flame records of engine explosions, as outlined in the next section.

For a great number of L-head chamber designs it



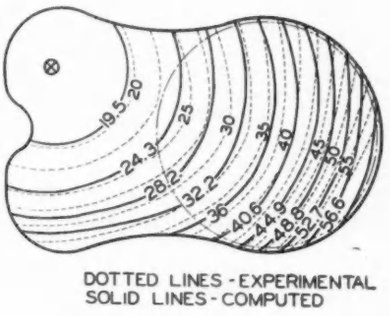




***Fig. 14—Experimental (dotted) and computed (solid) flame diagram, using variable reaction velocity.***

was found that for conditions obtaining at 1500 r.p.m., full load, maximum power air-fuel ratio and spark advance for borderline detonation, the reaction velocity follows the general pattern shown in Fig. 29, lower right.

For predetermining p-t relations of a design, using the procedure described in Fig. 9 and 10, the values for the reaction velocity (Col. 5) should be as follows: For the first inch of travel on the maximum travel line, 0.03 in. per deg.; from 1 in. to about ½ in. before the end wall, 0.05 in. per deg.; in the region where the flame front is substantially parallel to and about ½ in. on either side of the end wall, 0.063 in. per deg.; and for the rest of the travel, 0.05 in. per deg.

The analytical p-t curve obtained by following this method shows, in most cases, the fundamental characteristics of a chamber design, and enables the designer to predict, with a fair degree of accuracy, the shape of the pressure rise, the value and location of the peak pressure, and the total combustion time.

## Flame Velocity and Reaction Velocity

Given a pressure-time record and a flame diagram of an engine explosion, the values of the reaction velocity can be evaluated, by reversing the procedure followed in determining the analytical pressure-time curve. The pressure and flame record shown in Fig.

***Figs. 15 (Left) and 16 (Table below)—Application of the step-by-step method in evaluating the reaction velocity from a given flame-and-pressure record.***

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Flame Position Start °Cr. Angle | Displaced Volume | Total Chamber Vol. | Pressure | Burned Volume | Volume Increment to Burn | Flame Front Area | Travel | Pressure Ratio for $P_o$ | Expansion Volume for Y, $V_{to}$ | Volume Ahead of Burning Increment | Expansion Vol. in Unburned Portion | Total Flame Travel During $\Delta t$ | Flame Position End, °Cr. Angle | Time $\Delta t$ | Reaction Vel. In./Deg. | Ave Flame Vel. In./Deg. | Distance of Incr. from Ign.—Inch |
| $t_o$ | $V_p$ | $V_{to}$ | $P_o$ | $V_x$ | $V_b$ | A | $l=\frac{V_b}{A}$ | Y | $V_E$ | $V_y$ | $V_t$ | $L=\frac{V_b+V_t}{A}$ | $t_t$ | $t_t-t_o$ | $S_r=\frac{l}{\Delta t}$ | $S=\frac{L}{\Delta t}$ | |
| −18.0 | 1.10 | 9.40 | 105 | | .5 | | .680 | 5.27 | 1.520 | 8.90 | 1.020 | 1.220 | +1.0 | 19.0 | .036 | .064 | .81 |
| +1.0 | .00 | 8.30 | 142 | 1.52 | .5 | 1.415 | .353 | 5.00 | 1.450 | 6.28 | .765 | .894 | 6.0 | 5.0 | .071 | .179 | 1.70 |
| 6.0 | .14 | 8.44 | 164 | 2.78 | .5 | 2.050 | .244 | 4.84 | 1.420 | 5.17 | .600 | .537 | 10.0 | 4.0 | .061 | .134 | 2.45 |
| 10.0 | .34 | 8.64 | 188 | 4.11 | .5 | 2.350 | .213 | 4.70 | 1.390 | 4.07 | .443 | .400 | 14.5 | 4.5 | .047 | .089 | 3.05 |
| 14.5 | .70 | 9.00 | 215 | 5.35 | .5 | 2.180 | .231 | 4.56 | 1.385 | 3.15 | .328 | .380 | 19.4 | 4.9 | .047 | .078 | 3.50 |
| 19.4 | 1.30 | 9.60 | 242 | 6.53 | .5 | 2.100 | .238 | 4.46 | 1.370 | 2.57 | .246 | .356 | 25.0 | 5.6 | .043 | .063 | 3.85 |
| 25.0 | 2.16 | 10.46 | 260 | 7.80 | .5 | 2.540 | .195 | 4.40 | 1.375 | 2.16 | .190 | .272 | 29.5 | 4.5 | .043 | .060 | 4.18 |
| 29.5 | 2.92 | 11.22 | 272 | 9.15 | .5 | 2.600 | .192 | 4.35 | 1.372 | 1.57 | .127 | .241 | 34.0 | 4.5 | .043 | .054 | 4.46 |
| 34.0 | 3.85 | 12.15 | 278 | 10.33 | .5 | 2.700 | .185 | 4.33 | 1.380 | 1.32 | .099 | .222 | 38.6 | 4.6 | .040 | .047 | 4.72 |
| 38.6 | 5.00 | 13.30 | 275 | 12.55 | .5 | 2.750 | .182 | 4.34 | 1.380 | .75 | .079 | .210 | 43.3 | 4.7 | .038 | .045 | 4.95 |

15 was obtained under conditions similar to those of the pressure card in Fig. 11. The steps in the calculations are shown in tabular form in Fig. 16. Starting, for instance, with the flame front at $F$ (see Fig. 15), at 28 deg. after ignition or 10 deg. ATC, we burn an increment of 0.5 cu. in. at constant volume and determine the corresponding distance

$$l = \frac{V_b}{A} = 0.213 \text{ in.};$$

after expansion, the flame will be at $F_1$ or a distance

$$L = \frac{v_b + V_1}{A} = 0.4 \text{ in.}$$

from the starting position $F$; by tracing the flame at $F_1$, the number of degrees corresponding to $L$ can be easily estimated; in this case it is 4.5 deg. Consequently, the reaction velocity will be

$$S_r = \frac{l}{4.5} = \frac{0.213}{4.5} = 0.0474 \text{ in. per deg.}$$

and the flame velocity

$$S = \frac{L}{4.5} = \frac{0.4}{4.5} = 0.089 \text{ in. per deg.}$$

The flame velocity varies along the flame front in accordance with its distortion; the values $S$ in Column 17 (Table in Fig. 16) represent the equivalent uniform expansion in all directions, or, in other words, the average flame velocity.

The reaction velocity is assumed to be constant along the flame front. In Fig. 17 the values of $S$ and $S_r$ are plotted against the distance, along the maximum travel line, from the ignition point to the middle of the increment bounded by the flame fronts $F$ and $F_1$. The shape of the reaction-velocity curve is typical for a chamber with a flat roof, uniform height, and having no clearance space (Fig. 9). The effect of chamber contour upon reaction velocity will be discussed later.

The size of the volume increment $v_b$ has no appreciable effect upon the calculated reaction velocity, except at start, when the flame is still spherical. The dots at the distance 0.61 in. (Fig. 17), represent the reaction velocity calculated analytically for an infinitesimally small increment and the value for the corresponding instantaneous flame velocity determined graphically from a flame travel vs. time curve. The equilibrium pressure is very little affected by the increment size.

### Combustion Zone and "Effective" Reaction Velocity

From the results of other investigators (15, 16, 1) it appears that the combustion zone has a definite width. By modifying the apparatus used with the ionization gaps, it was possible to obtain records of the ionization current at two points in the chamber (see Fig. 18). A comparison of these current records with the neon-tube flash records indicated that the flash occurred at the very instant the current started. By interpreting the current-time relations in terms of temperature, using a method similar to that of Lusby (17), it was found that, after the arrival of the flame at the gap, there is a very steep temperature rise, lasting a few degrees, from $A$ to $B$ or $A'$ to $B'$; at Gap 1 there is a second temperature rise, from $C$ to $D$, while at Gap 2 this second rise is missing. The first steep temperature rise at both gaps suggests an

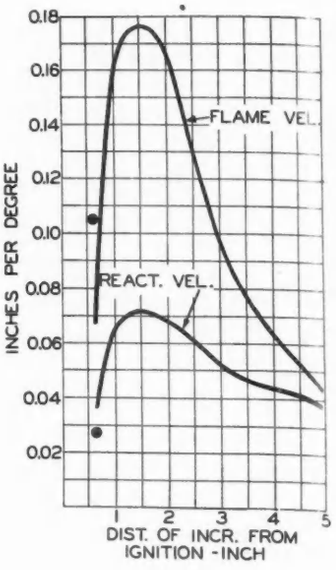



*Fig. 17 — Variation of mean flame velocity and reaction velocity characteristic of the chamber form shown in Fig. 9.*

energy release at a very high and constant rate—possibly corresponding to the passing of the active zone at that point. The second temperature rise, from $C$ to $D$ at Gap 1, may be due to the compression of the burned gases at that point; at Gap 2 this second rise is missing, because, after the reaction at that point is completed, there is no increase in pressure. This interpretation of the ionization-current records of an engine explosion would indicate that the active zone has a certain width, which would explain the occurrence of peak pressures in bombs after the flame has completely filled the container, and may, in part at least, be responsible for the slow pressure rise at start. The experimental evidence at hand, however, is not sufficient to include the zone width in the analysis; it is felt, moreover, that as far as the gross mechanism of engine combustion is concerned, such considerations would not add materially in interpreting the effect of the variables governing engine combustion.

It should be clearly understood that the ionization-gap method employed to trace the flame movement does not furnish as accurate a picture of the actual flame contour as high-speed motion pictures do; more likely it will average the irregular contour by substituting a flame front of less area, so that the computed linear reaction velocity may be somewhat high.

The same considerations hold true also for the irregularities of the flame shape in the vertical plane.

Therefore, the reaction velocity in Fig. 17 is intended to mean the linear velocity of a substantially smooth flame front which causes the same mass to burn and the same rise in pressure as the actual velocity of the actual "ragged" flame front of unknown contour; it should be referred to as the "effective linear reaction velocity."

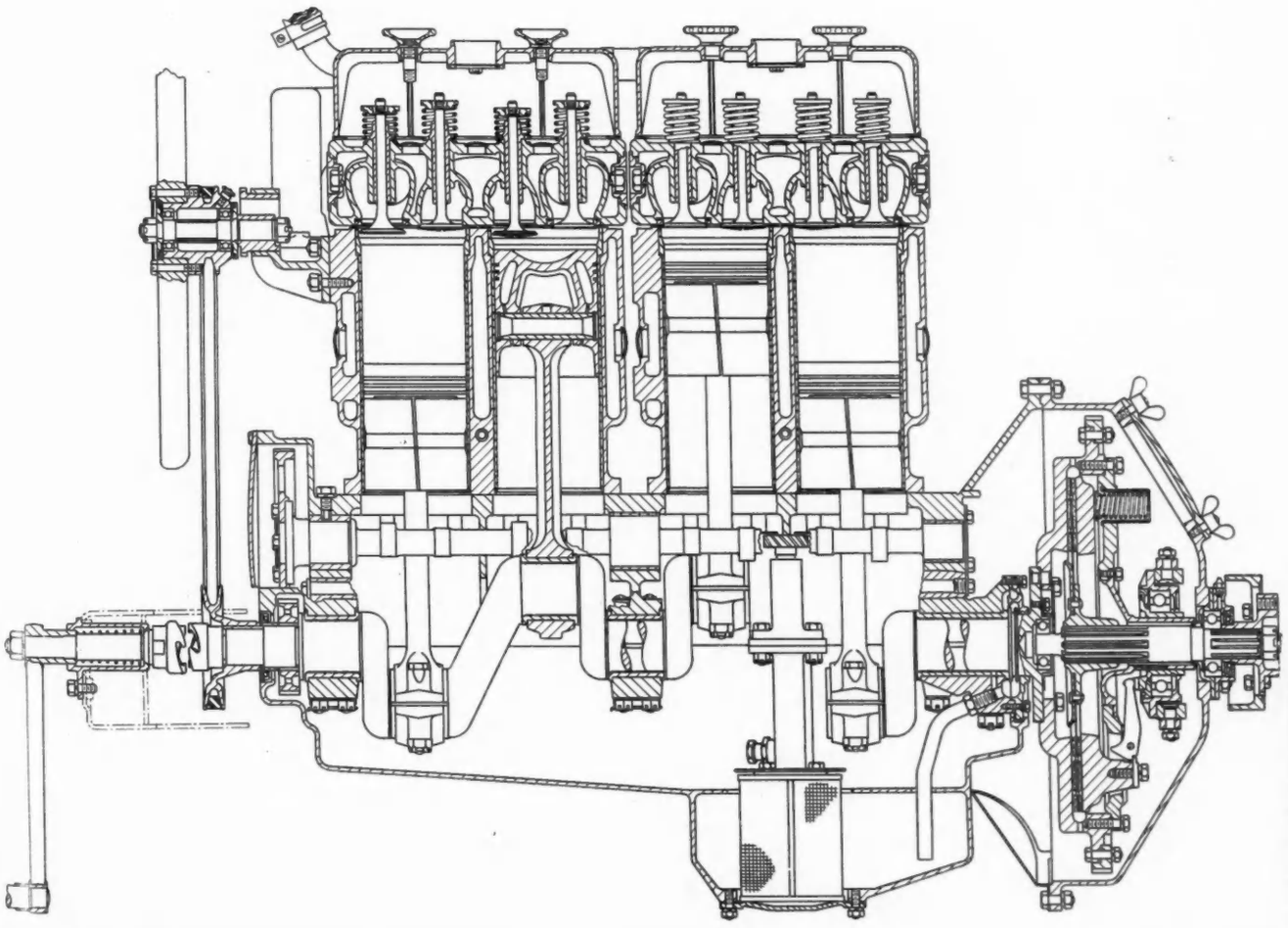
***Owing to space limitations it has been necessary to divide this article in two parts. The concluding part will appear in an early issue.***

# SCAMMELL FOUR-CYLINDER ENGINE for TRUCK or TRACTOR

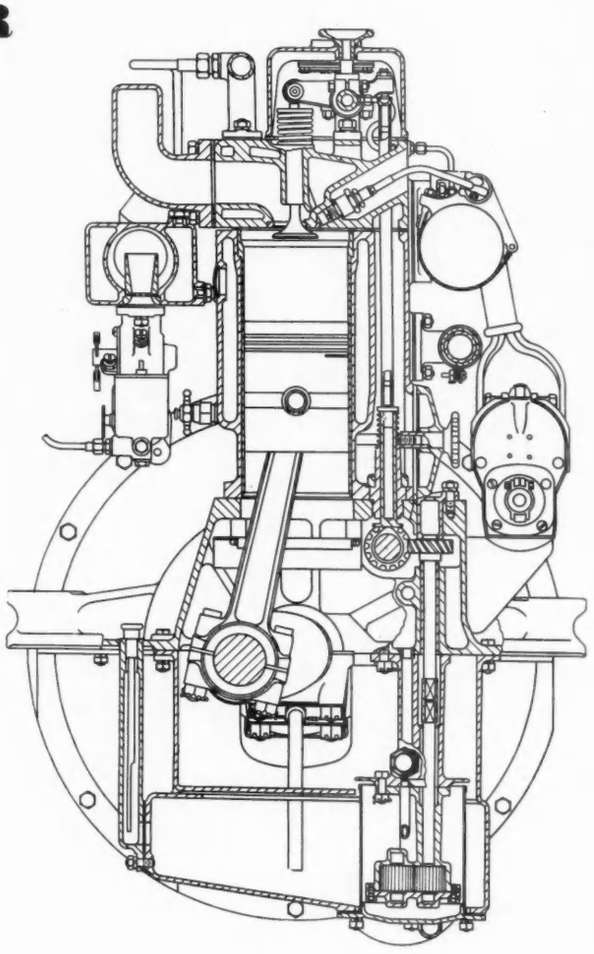
***Longitudinal Section***

Of exceptionally large piston displacement for a four-cylinder gasoline engine, the Scammell is used for heavy duty trucks, articulated tractor-trailer combinations and trailer haulage. Known as the 7-liter type it has a bore and stroke of 5 in. x 5½ in., the piston displacement being 432 cu. in. At 1800 r.p.m. it develops 82 b.hp., with a compression ratio of 5.5 to 1. As with certain other heavy duty engines of British manufacture, magneto ignition is used.

The cast iron cylinders are separate from the crankcase and in pairs, with overhead valves and dry liners of hardened cast iron (500 Brinell). Exhaust valves have inserted seats of stellite with a cast iron head, or aluminum-bronze for both inlet and exhaust with



# SCAMMELL FOUR-CYLINDER ENGINE for TRUCK or TRACTOR



***Transverse Section***

a head of aluminum alloy, an optional feature. Pistons have split skirts and are of aluminum ("Y") alloy with three pressure rings but no scraper.

The three-bearing crankshaft is of 2½ in. diameter as to both pins and journals; pins are 2½ in. in length and journals 2¾ in. In both cases the bearing shells are of bronze with white-metal lining. Connecting rods are of H section steel, 12¾ in. between centers.

Complete with flywheel the engine weighs 1260 lb.

# New Vortox Air Cleaners

VORTOX MANUFACTURING CO., Claremont, Calif., has announced two new Vortox oilbath-type air cleaners, Type R and Type S. Both operate on the same principle, the chief difference being that in Type R the air is taken in through a vertical tube, while in Type S it is taken in around the edge of the cup. Type R is recommended for use where chaff or fibrous material must be guarded against, or where it is desirable to reduce the dust load by extending the inlet of the cleaner.

In these cleaners the air, upon entering, flows through spiral passages formed by the walls of the cup and vortex chamber, into the vortex chamber itself. The resulting vortex action picks up oil, which is sprayed against the vortex-chamber wall, saturating and washing the filter element. The air inlets are submerged in oil and it is claimed that a strong vortex action is maintained even at low air velocities. Thus oil is delivered to the filtering element as soon as the engine is started.

There is said to be a triple cleaning action in this device, due to the centrifugal effect, the oil spray, and the filter. The rapid circulation of the oil is said to keep the filter clean, and servicing of the cleaner consists in removing the cup, emptying the oil and dirt, and refilling with a light oil.

*Andrew Fuller Johnson*

# Credit to a Craftsman

***Andrew Fuller Johnson is the same alert and active designer of automobile bodies who originally fashioned carriages***

THE MAJORITY of his 85 years having been devoted to carriage and automobile body design, Andrew Fuller Johnson on Nov. 6 received recognition of his services to the industry when he was awarded a life membership in the Society of Automotive Engineers at a Detroit section meeting. The award was made by W. J. Davidson, president of the S.A.E.

The body designer is rare who has not, at some time in his career, studied under Mr. Johnson—the man who has done more to forward the art of body designing and drafting in this country than any other individual. Now an elderly man, alert and active as principal of the correspondence School for Automobile Body Makers, Designers and Draftsmen in Gray, Me., Mr. Johnson continues to instill in automotive body designers the craftsmanship which he taught carriage designers before the advent of the automobile.

His career, not particularly eventful but with a lasting effect on automobile design, began in Gray, Maine, when he started work as a carriage builder's apprentice in 1870. In 1881 he went to New York to work for the Brewster Body company and attend the Technical School for Carriage Draftsmen and Mechanics. The excellence of his work at this school won for him a prize award sending him to Paris to study under Dupont, the most famous carriage designer of the times. On his return to this country he exhibited his drawings and designs at numerous shows and conventions and worked for a number of builders.

For a time he ran a school of his own at Merrimac, Mass., then, in 1892, he was invited to take charge of the Technical School. With the assistance of two instructors Professor Johnson conducted day, evening and correspondence courses.

About the turn of the century individual automobile companies began contributing to the support of the work and attention was given in the classes to the problems of automobile body design. Within a few years this was the sole course.

Although financial difficulties forced the closing of the school in 1918, the trustees permitted Johnson to finish the uncompleted courses of the correspondence students. While at that time he had no idea of continuing it indefinitely, he has continued ever since to teach by mail from Gray, Maine, under the school's present name.

Mr. Johnson's interest in automotive affairs has not declined with the passing years. He has missed attending but one automobile show since 1900. After all, he says, the transition from carriage to automobile was not revolutionary for the designer. It merely added another problem—that of making room for the mechanical apparatus while retaining the elegance and appearance of a carriage.

In his opinion the primary purpose of the passenger automobile is to carry people from one place to another and back in comfort and ease. All other considerations should be held off until this requirement is met. Proper design, he contends, depends on attention to small details coupled with a close knowledge of traveling habits. Proper placing and arrangement of hardware is more important than flashy trim. His opinion of streamlining is that it "amounts to nothing except in the improvement of the car's appearance." He distinctly dislikes ultra-modern "dinosaurs on wheels."

Mr. Johnson feels that the car buyer today approaches his purchase with much the same attitude as the carriage buyer of yesteryear—in that the most important consideration is the car body. The motive power's satisfactory performance is taken for granted. He feels, too, that cars must be designed to feminine taste since, ultimately, they are the buyers of passenger automobiles.

# MEN and MACHINES

## *Four-station press, threading and other shop equipment*

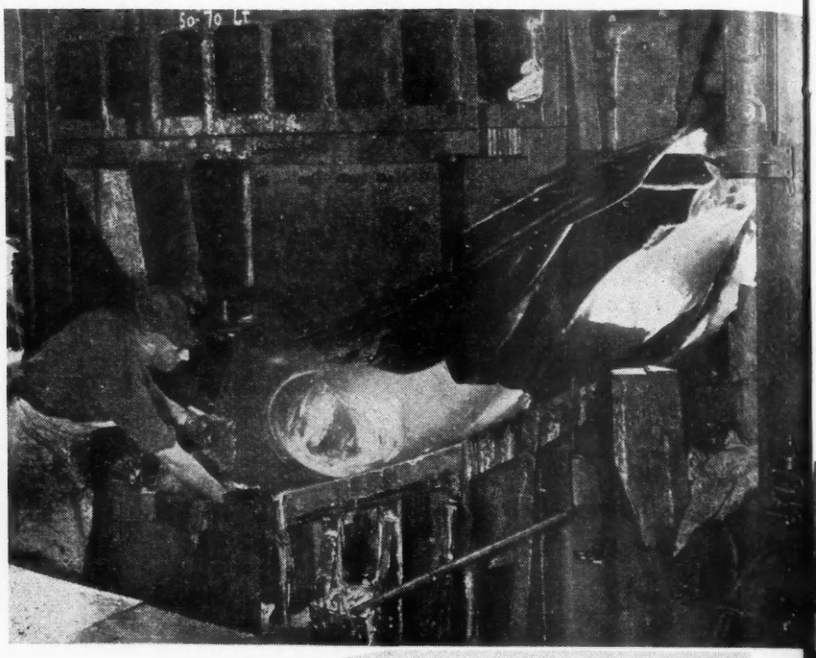
AN EXCELLENT example of modern press shop technique is the method of stamping the front end sheet metal for 1940 Buick cars in which the front fender and shroud, the hood side and the headlamp body are formed in an integral unit. The "three-in-one" stamping provides a strong, rigid assembly and eliminates joints which require lining up during assembly and sealing. The stamping is made from a blank of sheet steel which is 54 in. wide, 95 in. long, and 0.078 in. thick. At the point of greatest stretching—the nose of the headlamp—the metal is elongated as much as 50 per cent.

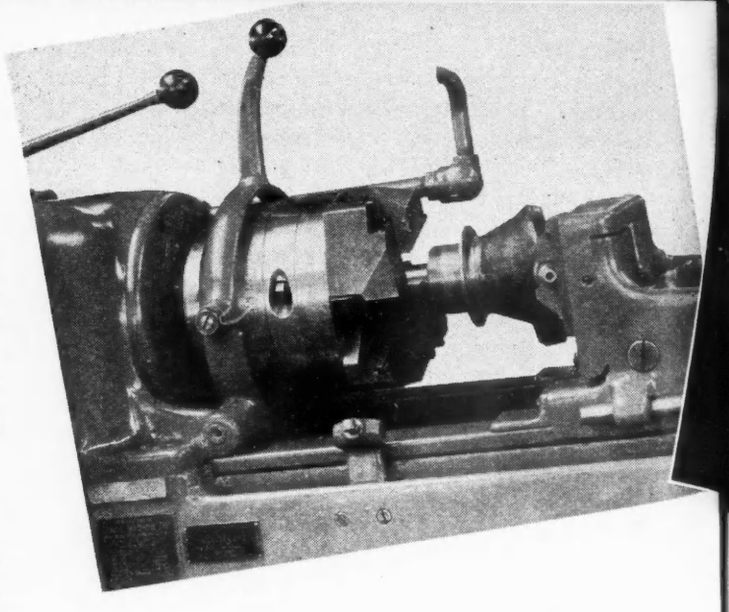
First operation is the forming of the blank. This is followed by kneading and rolling to develop proper ductility and metallurgical qualities without which it would be impossible to produce a stamping free of surface imperfections.

After the first draw in a Hamilton press, the stamping is routed to a press which is fitted with two separate die stations, one for rough-trimming the rear end and the other for re-drawing the rear end. The next operations are performed on a press whose bed accommodates four separate die stations. The first station takes the finish re-draw of the rear end and the second the rough trim of the nose. At the third station the still closed headlamp is perforated. Before going to the fourth station the stamping is removed to an annealing furnace where the headlamp section is heated to relieve strains due to the deep drawing operations. The annealed headlamp area is re-drawn in a small press and scale is removed from the annealed section.

The stamping is returned to the last die station in the four-station press for sharpening the edges and embossing the headlamp section. In another three-station press the entire unit is finish trimmed and flanged all around, completing the basic forming operations.

All holes are pierced in a single operation on a hydraulic Pierson press. The outside of the stamping is re-flanged on a special machine. Metal finishing operations are followed by assembly and fitting of interior shroud panels and welding of brackets. Finally, the unit goes to a bonderizing unit for chemical cleaning and application of Bonderite coating which protects the metal against corrosion.





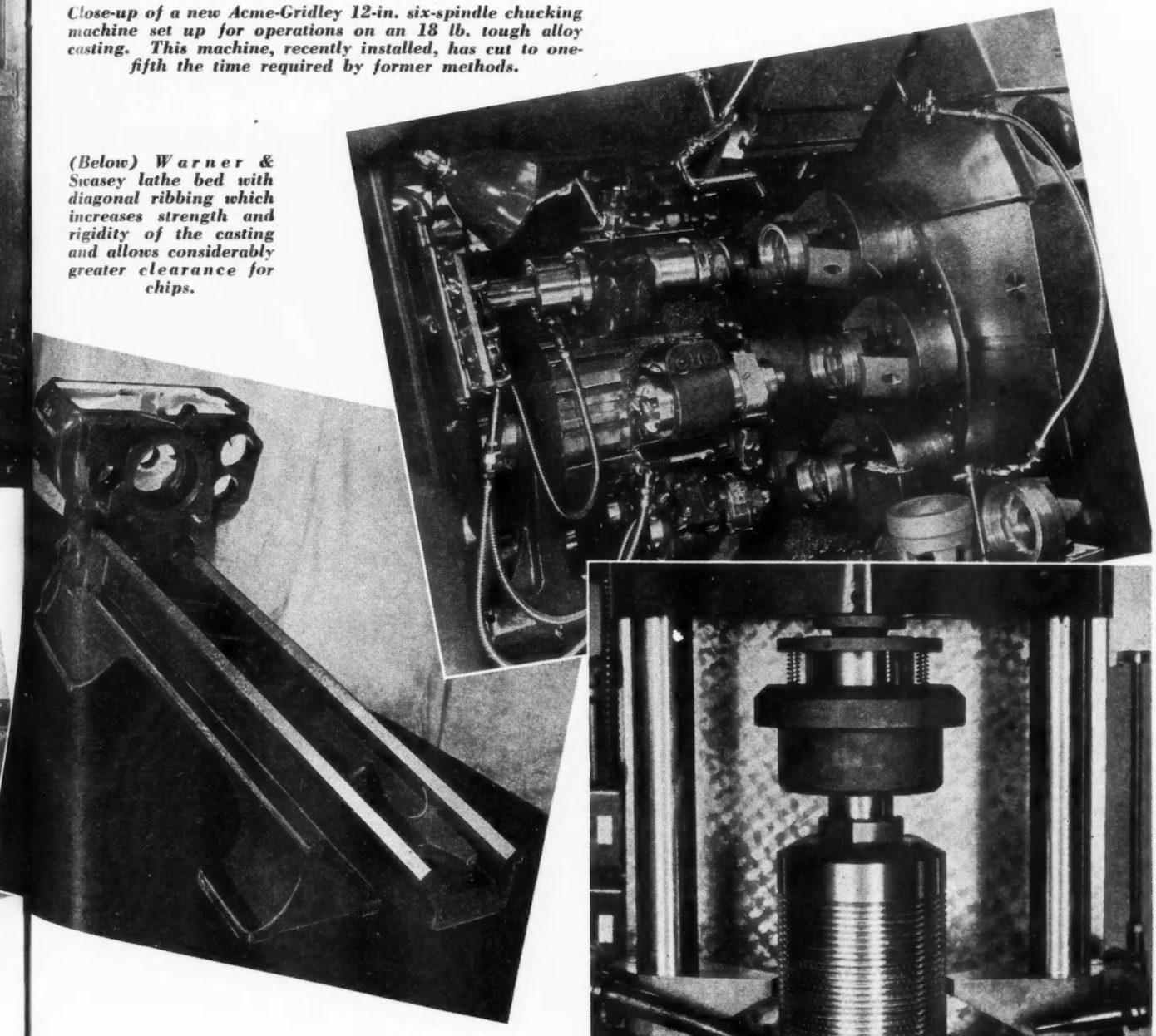
*A Landmaco threading machine, manufactured by the Landis Machine Co., equipped with special fixtures for threading steering pivots.*

*(Top) First drawing operation on 1940 Buick front fenders is performed on this Hamilton press. The steel blank weighs 75 lb., is 54 in. wide, 95 in. long, and 0.078 in. thick.*

# and chucking machines, grinders, lathes create new interest for the industry

*Close-up of a new Acme-Gridley 12-in. six-spindle chucking machine set up for operations on an 18 lb. tough alloy casting. This machine, recently installed, has cut to one-fifth the time required by former methods.*

*(Below) Warner & Swasey lathe bed with diagonal ribbing which increases strength and rigidity of the casting and allows considerably greater clearance for chips.*



*(Right) Set-up for broaching the internal bore of large steel tractor ring gears. The machine is a standard Colonial Broach Co. open side Utility press rated at 10 tons.*

A NEW type of construction that is said to increase the strength and rigidity of cast-iron alloy lathe beds as much as 30 per cent has been announced by the Warner & Swasey Co. Now standard on all but the smallest of the company's machines, the new construction features diagonal ribbing, instead of conventional box type ribbing. In addition, all of the stiffening sections are on the outside walls of the bed. Warner & Swasey engineers point out that this not only gives greater freedom from twist and vibration, important because of the current demand for higher speeds and closer limits without subsequent grinding, but also makes it easier for chips to clear through the openings and fall into the pan.

THE Landis Machine Co., Waynesboro, Pa., recently supplied a foreign manufacturer of automobiles with one of its Landmaco threading machines equipped with a special holding fixture and a floating centering mandrel for handling the threading of steering pivots. On this particular machine a spring loaded centering mandrel is located within the bore of the die head and of the machine spindle. The end of the mandrel protrudes beyond the face of the die head a sufficient distance to engage the steering pivot before the threading operation commences. The mandrel has a close sliding fit within the bore of the pivot and thus assures concentricity between the bore of the pivot and the thread. An adjustment is provided at the rear end of the machine spindle to increase or decrease the spring pressure on the mandrel, if desired.

The conventional carriage front on this machine is replaced by a special holding device which supports the steering pivot in proper alignment with the axis of rotation. The shape of the part is such that no clamping device is necessary on the holding fixture. The pivot is merely supported on the centering mandrel and is driven by lugs which engage the turnbuckles. Both horizontal and vertical adjustment is provided for the holding fixture to assure permanent alignment of the work with the threading head.

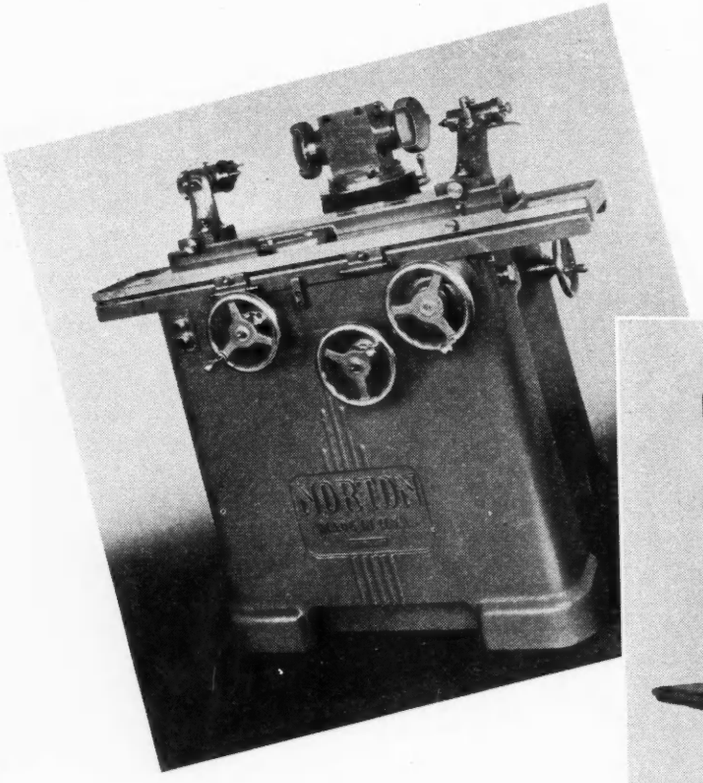
THE new Acme-Gridley 12-in. model RPA six spindle chucking machine offered by the National Acme Co. has mechanically operated feeds and speeds, and features a full hydraulic chuck operation. It is equipped with high precision adjustable anti-friction bearings and has full splash lubrication.

Maximum swing of the new Acme-Gridley is 12 in.; maximum turning length is 12 in. Spindle speeds range from 23 to 203 r.p.m. when the pull shaft is driven at 500 r.p.m. A 40-hp drive motor is required. Maximum standard cam size is 8 to 12 in. for the tool slide, 2 to 4 in. for the upper and lower cross slides.

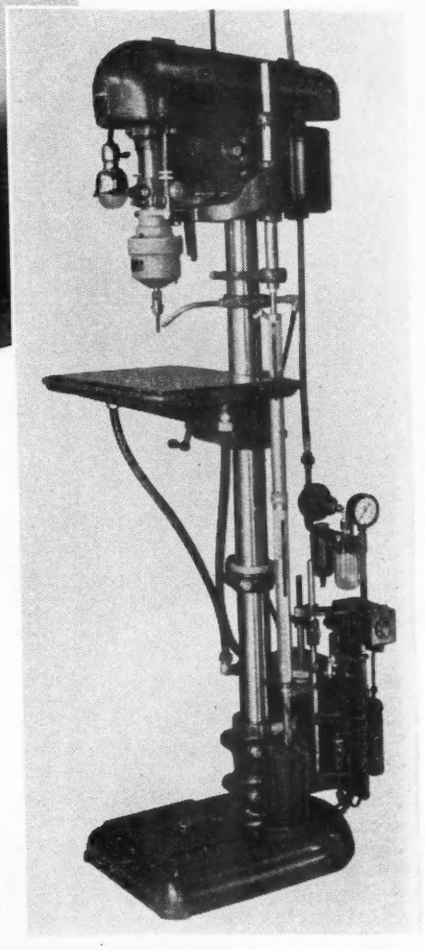
INTERESTING detail of a new No. 2 cutter and tool grinder recently announced by the Norton Co., Worcester, Mass, is the anti-friction table which runs on balls held in a chain-like container. Hardened steel ways are used and an adjustable braking device facilitates creating a "drag" on the table or locking it securely in some specific position.

The cartridge type ball bearing wheel spindle on this machine is driven by a one horsepower motor carried on the lower end of a heavy column. A single vee belt from the motor through the column drives the spindle. Graduations on the wheel head enable setting the spindle at any angle in a horizontal plane.

(*Turn to page* 558)




***Front view of Norton No. 2 cutter and tool grinder.***



***"Universal" air operated tapping machine manufactured by the Procunier Safety Chuck Co.***

# NEWS OF THE INDUSTRY

## GM Offers Vigorous Defense In Sherman Anti-Trust Case

### *Corporation Parades Many Witnesses After Judge Lindley Denies Motion for Dismissal of Charges*

Trial of the government's Sherman anti-trust case against General Motors Corp., three of its affiliated corporations and 17 individuals in northern Indiana district federal court at South Bend before a jury and Judge Walter C. Lindley, is expected to be completed before Nov. 23.

The government rested its case Oct. 25 after presenting 68 witnesses and introducing a voluminous amount of documentary evidence. The greater portion of those testifying for the prosecution were former GM dealers who had lost their franchises and attributed their cancellations to their non-use of GMAC financing.

In denying a defense motion for dismissal of the charges at the completion of the government's case, Judge Lindley said that, "If I should allow this motion the supreme court would not have the opportunity to decide what the law is in a case which is . . . without precedent."

Among the first defense witnesses were: John J. Raskob, GM director and former chairman of the finance committee; Donaldson Brown, vice-chairman of the GM board; Nelson C. Dezendorf, vice-president of GMAC; John J. Schumann, Jr., president of GMAC; William F. Hufstader, general sales manager of Buick and W. J. Mougey, Pontiac zone manager at Chicago. Dezendorf, Schumann, Hufstader and Mougey are defendants.

Mr. Raskob told of the conditions which led to formation of the financing company and told the jury the main purpose was to give credit to the working man of moderate means which he could not obtain from a bank at that time. Dezendorf spent nearly two days on the witness stand explaining all phases of GMAC and told the jury that many of the various changes in the rate plans were worked out by him.

The defense then began a parade of present GM dealers who were to testify that they had been dealers for several years, did not use GMAC financing to a major percentage and had had no difficulties with General Motors because of this. The government, however, objected to the testimony of the first of these witnesses and was upheld by Judge Lindley on the theory that because some dealers were not coerced

(*Turn to page* 553, *please*)

## Increase Reflected In MEMA Index

Original equipment shipments to vehicle manufacturers during September of this year were indexed at 133 (Jan. 1925, equalling 100) by the Motor and Equipment Manufacturers Association. This was 37 points above August of this year and 42 points above September a year ago.

The MEMA grand index for September, including the above, service parts shipments, accessories shipments, and service equipment shipments to wholesalers was set at 106. This was 11 points above August of this year and 24 points above September, 1938.

## United Specialties Reports on Income

Statement of income and earned surplus for the eight months ended Aug. 31, recently announced by United Specialties Co., indicated a net income of $71,508.09. A deficit as of Jan. 1 of $35,873.48 brought earned surplus as of Aug. 31, 1939, to $35,634.61.

Main office of the company is to be moved to Chicago, and will be located in the offices of the Chicago division, 9705 Cottage Grove Ave.

International

### Last Laugh

**. . . and this horse in London is obviously enjoying it. This was one English motorist's way of obtaining transportation when his monthly ration of gasoline was used up too soon. The basis of the rationing is eight miles for each of the 25 working days per month. Cars have been grouped in the following horsepower classes for monthly fuel allotment: Class A—up to 7 h.p. . . 4 gal.; Class B—8-9 h.p. . . 5 gal.; Class C—10-12 h.p. . . 6 gal.; Class D—13-15 h.p. . . 7 gal.; Class E—16-19 h.p. . . 8 gal.; Class F—20 h.p. and over . . 10 gal. The fuel rationing scheme is of an experimental nature and, as was officially announced, covered only a two-month period up to Nov. 15 when revision was expected.**

## New Truck Registrations

| | September 1939 | August 1939 | September 1938 | NINE MONTHS 1939 | NINE MONTHS 1938 | Per Cent Change, 9 Months 1939 over 1938 | Per Cent of Total Nine Months 1939 | Per Cent of Total Nine Months 1938 |
|---|---|---|---|---|---|---|---|---|
| Chevrolet | 9,132 | 14,327 | 6,577 | 127,774 | 94,193 | + 35.5 | 34.53 | 32.44 |
| Ford | 7,288 | 12,090 | 8,296 | 97,351 | 81,759 | + 19.0 | 26.31 | 28.16 |
| International | 6,297 | 6,101 | 5,296 | 48,819 | 42,712 | + 14.0 | 13.19 | 14.71 |
| Dodge | 4,169 | 4,709 | 2,285 | 40,497 | 28,406 | + 42.3 | 10.94 | 9.78 |
| G. M. C. | 3,091 | 3,031 | 1,513 | 25,566 | 15,866 | + 61.0 | 6.91 | 5.46 |
| Plymouth | 439 | 793 | 391 | 7,106 | 5,864 | + 21.0 | 1.92 | 2.02 |
| Mack | 556 | 524 | 353 | 4,789 | 2,981 | + 60.5 | 1.29 | 1.03 |
| Diamond T | 496 | 449 | 318 | 3,812 | 3,338 | + 14.1 | 1.03 | 1.15 |
| White | 483 | 365 | 269 | 3,410 | 2,633 | + 29.8 | .92 | .91 |
| Studebaker | 165 | 238 | 167 | 1,712 | 1,533 | + 11.7 | .46 | .53 |
| Autocar | 191 | 185 | 129 | 1,598 | 1,229 | + 30.2 | .43 | .42 |
| Brockway | 157 | 146 | 123 | 1,359 | 942 | + 44.2 | .37 | .32 |
| Federal | 159 | 158 | 135 | 1,167 | 1,071 | + 9.0 | .32 | .37 |
| Willys-Overland | 99 | 92 | 143 | 1,153 | 1,528 | − 24.4 | .31 | .53 |
| Divco | 64 | 84 | 88 | 1,046 | 969 | + 7.8 | .28 | .33 |
| Reo | 18 | 28 | 252 | 817 | 2,218 | − 63.1 | .22 | .76 |
| Bantam | 59 | 59 | | 446 | | | .12 | |
| Hudson | 11 | 28 | 28 | 356 | 634 | − 43.7 | .10 | .22 |
| Sterling | 23 | 38 | 19 | 254 | 190 | + 33.8 | .07 | .07 |
| Indiana | 14 | 12 | 34 | 153 | 354 | − 56.7 | .04 | .12 |
| F. W. D. | 12 | 8 | 17 | 137 | 235 | − 41.6 | .04 | .08 |
| Miscellaneous | 60 | 58 | 137 | 757 | 1,688 | − 55.2 | .20 | .59 |
| Total | 32,983 | 43,523 | 26,570 | 370,079 | 290,343 | + 27.8 | 100.00 | 100.00 |

# More Than 200,000 Out Of Work Due to Chrysler Strike

### *Prolonging of Siege Brings Forth Signs of Additional Restiveness in the Industry and Communities Affected*

As the Chrysler strike approached the end of its fifth continuous week with 55,000 Chrysler employes still away from their jobs and an estimated 150,000 others in parts and related industries also out of work, conciliators representing the Michigan Labor Mediation Board and the United States Department of Labor reported that some progress was beginning to be made in negotiations for a new contract between the UAW-CIO and the corporation.

Agreement was near, it was indicated, on seniority rules and general grievance procedure but no disposition had yet been made of two major issues over which negotiations had been stymied almost since the start—the union shop in some form or other and a voice for the union in establishment of production rates. At various times in the negotiations these basic proposals, modified in one way or another, had come up but as this was written the corporation continued to stand by its guns in opposition to them.

Meanwhile the prolonging of the strike showed signs of creating additional restiveness and uneasiness in the industry and in the communities affected. Leading Detroit newspapers in the past week have carried front page editorials appealing to the workers to return to their jobs and to continue negotiations for a new contract while working. Most dramatic appeal was an almost full page newspaper advertisement signed by the associated Chrysler, Dodge, DeSoto, and Plymouth dealers of America, appealing to the workers to "get back to work." The dealer advertisement, as were the newspaper editorials, were promptly denounced by union leaders as being corporation-inspired.

Latest direct developments were the closing down of the Dodge truck plant on Oct. 31 on charges by the corporation, supported by production statistics, of a slow-down in various departments of the plant which so disrupted assembly procedure that work had to be discontinued. The Dodge forge plant was not able to operate on Nov. 7 because, according to W. J. O'Neil, president and general manager of the division, pickets surrounding the plant prevented workers from entering. The union countered the truck plant closing with charges of a lockout and insisted that no workers had been prevented from entering the forge plant because none had appeared for work.

## Sale of Lycoming Assets Approved

Sale of substantially all assets of Lycoming Manufacturing Co. to Aviation Corp. has been approved by Judge Thomas W. Slick, in United States district court, South Bend. According to the agreement Aviation Corp. will issue 206,000 shares of its common capital stock, valued in the market at about $1,493,500 or $7.25 a share to the Lycoming company in payment for the Lycoming company's assets. In addition the Aviation corporation agrees to assume all liabilities of the Lycoming company incurred after reorganization proceedings were launched in federal court. The Lycoming company was named as a subsidiary debtor in the federal reorganization of the Auburn Automobile Co. Lycoming and Aviation officials had reached an agreement on terms of the sale and sought the approval of the court in a hearing in the auxiliary court room of the federal building. In the statement of the merger plan the Aviation corporation said it desired to extend its business and consolidate operations in one location. The corporation entered the negotiations to avoid delay in building new plants and to facilitate compliance with suggestions of the War Department, the announcement stated. Aviation Manufacturing Corp., wholly owned subsidiary of Aviation Corp., it is said, now leases part of the Lycoming plant for the production of military and commercial aircraft.

## MEN . . . . . .

**F. J. Griffiths** has been appointed executive vice president in charge of the newly created Alloy Steel division of Copperweld Steel Co. The appointment follows the earlier announcement that the Copperweld Steel Co. has purchased the plants and assets formerly owned by American Puddled Iron Co.

**W. M. Hayes,** Detroit district manager of the Air Reduction Sales Co. for the past thirteen years, has joined the sales organization of P. R. Mallory & Co., Inc.

**S. W. Gray** has been named general manager of the Marvel-Schebler Carburetor division of Borg-Warner Corp. He succeeds **C. M. Kaltwasser** who is now attached to the central office of the corporation.

**E. J. Greene** has been elected assistant treasurer of Chain Belt Co. He was formerly assistant treasurer and purchasing agent of Baldwin-Duckworth Chain Corp. which was recently merged with Chain Belt Co.

**Joseph E. Otis, Jr.,** formerly president of Stewart Warner Corp., Chicago, has been elected president of Dodge Manufacturing Corp. He succeeds the late George C. Miller.

**P. F. Hackethal** has been appointed chief of engineering and production for Everel Propeller Corp. Mr. Hackethal was formerly chief engineer of the Smith Propeller Co., where he was responsible for the development of the Smith controllable pitch propeller.

**Henry D. Rolph** has been promoted to the position of director of export sales for the Yale & Towne Mfg. Co. Mr. Rolph's headquarters will be in the Chrysler Building, New York City.

**Joseph Geschelin,** Detroit Technical Editor, AUTOMOTIVE INDUSTRIES, will address the Syracuse Section of the Society of Automotive Engineers on Nov. 27. Mr. Geschelin will discuss the

engineering features of the 1940 motor cars.

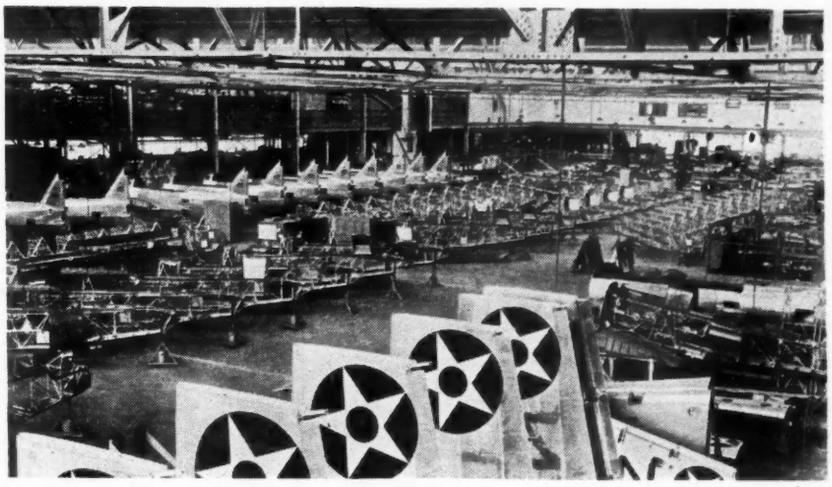
**James S. Marvin,** assistant general manager and general traffic manager of the Automobile Manufacturers Association, will retire from the Association staff on Jan. 1 and open offices in New York for consultation on transportation and trade association matters.

**C. O. Richards,** who has been acting as chief body engineer for Cadillac-LaSalle has been elevated to the post of assistant chief engineer. **William J. Tell** succeeds Mr. Richards as chief body engineer.

**James S. Murray,** Pittsburgh, Pa., has been appointed manufacturers' representative for the exclusive sale of products of the Kelly Reamer Co. in the Pittsburgh territory.

**H. C. McCaslin** has been appointed chassis engineer for Willys-Overland Motors, Inc.

**Terry Fisher** has been placed in charge of the Northern Indiana territory for Cutler-Hammer, Inc., Milwaukee, Wis.



Acme

## Additions

**Typical of scenes in aircraft plants throughout the country is this view of an assembly room in the plant of North American Aviation, Inc. Lifting of the embargo has again started plants pushing production for foreign consumers. This view, however, shows a group of planes which will be added to our own country's air force. North American is increasing floor space and production facilities by 50 per cent and is also reported as negotiating for further ground to be used in expansion.**

## Monthly Motor Vehicle Production (U. S. and Canada)

| | PASSENGER CARS | | TRUCKS | | TOTAL MOTOR VEHICLES | |
|---|---|---|---|---|---|---|
| | 1939 | 1938 | 1939 | 1938 | 1939 | 1938 |
| January | 291,444 | 168,890 | 62,502 | 58,062 | 353,946 | 226,952 |
| February | 250,897 | 151,133 | 61,244 | 51,464 | 312,141 | 202,597 |
| March | 312,392 | 186,341 | 77,097 | 52,106 | 389,489 | 238,447 |
| April | 286,200 | 190,111 | 68,063 | 47,818 | 354,263 | 237,929 |
| May | 249,455 | 168,599 | 63,759 | 41,575 | 313,214 | 210,174 |
| June | 257,289 | 147,545 | 66,946 | 41,857 | 324,235 | 189,402 |
| July | 155,850 | 112,114 | 62,628 | 38,336 | 218,478 | 150,294 |
| August | 62,452 | 61,687 | 40,891 | 35,259 | 103,343 | 96,946 |
| September | 165,119 | 69,449 | 27,553 | 20,174 | 192,672 | 89,623 |
| October | ..... | 192,906 | ..... | 22,380 | ..... | 215,296 |
| November | ..... | 335,767 | ..... | 54,638 | ..... | 390,405 |
| December | ..... | 341,524 | ..... | 65,492 | ..... | 406,960 |
| Total | ..... | 2,126,066 | ..... | 529,161 | ..... | 2,655,171 |

## 40 YEARS AGO

The Canadian Government has been experimenting for some time with various motive powers as a propelling force for mowers, reapers and other agricultural machinery. The tests have been made at Montreal, and one of the most recent was the driving of a gang plow by a gasoline motor built by the Haynes-Apperson Co., Kokomo, Ind. It is said the motors will be attached to other farm machinery and produced in quantities.

From *The Horseless Age*, November, 1899.

## New Passenger Car Registrations

| | September 1939 | August 1939 | September 1938 | NINE MONTHS 1939 | NINE MONTHS 1938 | Per Cent Change, 9 Months, 1939 over 1938 | Per Cent of Total Nine Months 1939 | Per Cent of Total Nine Months 1938 | ELEVEN MONTHS MODEL YEAR 1939 | ELEVEN MONTHS MODEL YEAR 1938 | Per Cent Change |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chevrolet | 24,099 | 40,666 | 24,348 | 448,756 | 337,440 | + 33.0 | 22.86 | 25.11 | 552,740 | 442,855 | + 24.8 |
| Ford | 18,948 | 36,933 | 20,735 | 355,706 | 283,143 | + 25.7 | 18.12 | 21.07 | 422,292 | 330,513 | + 28.0 |
| Plymouth | 27,943 | 25,198 | 15,099 | 282,594 | 189,052 | + 49.6 | 14.40 | 14.06 | 349,886 | 238,731 | + 46.8 |
| Dodge | 10,153 | 12,798 | 3,545 | 149,466 | 73,234 | +104.0 | 7.62 | 5.45 | 177,535 | 98,845 | + 80.0 |
| Buick | 9,206 | 10,688 | 7,058 | 144,025 | 110,394 | + 31.0 | 7.34 | 8.21 | 181,856 | 144,202 | + 26.0 |
| Pontiac | 7,248 | 7,978 | 3,131 | 109,407 | 66,595 | + 64.4 | 5.57 | 4.95 | 135,147 | 89,482 | + 51.0 |
| Oldsmobile | 6,369 | 8,480 | 3,394 | 99,647 | 63,836 | + 56.1 | 5.08 | 4.75 | 125,050 | 83,985 | + 49.0 |
| Studebaker | 7,778 | 7,818 | 3,081 | 58,921 | 26,631 | +121.0 | 3.00 | 1.98 | 68,389 | 34,332 | + 99.1 |
| Chrysler | 3,340 | 5,028 | 1,576 | 51,895 | 33,618 | + 54.3 | 2.64 | 2.50 | 62,692 | 45,981 | + 36.5 |
| Mercury | 3,397 | 5,335 | ..... | 47,434 | ..... | ..... | 2.42 | ..... | 54,269 | ..... | ..... |
| De Soto | 3,620 | 5,010 | 1,500 | 42,291 | 25,786 | + 64.2 | 2.15 | 1.92 | 50,376 | 34,969 | + 43.9 |
| Nash | 3,770 | 3,362 | 1,977 | 40,146 | 24,590 | + 63.2 | 2.05 | 1.83 | 45,750 | 31,936 | + 43.1 |
| Packard | 6,796 | 4,541 | 2,673 | 38,892 | 35,483 | + 9.7 | 1.98 | 2.64 | 47,959 | 46,292 | + 3.8 |
| Hudson | 4,886 | 3,015 | 2,020 | 38,273 | 28,973 | + 32.0 | 1.95 | 2.16 | 47,680 | 38,242 | + 24.9 |
| La Salle | 837 | 1,528 | 547 | 15,454 | 9,882 | + 56.4 | .74 | .79 | 20,058 | 13,321 | + 50.0 |
| Lincoln | 1,086 | 1,491 | 873 | 14,643 | 12,813 | + 14.1 | .75 | .95 | 18,005 | 16,263 | + 10.9 |
| Cadillac | 656 | 867 | 416 | 9,384 | 7,490 | + 25.2 | .48 | .56 | 12,040 | 8,747 | + 38.0 |
| Willys-Overland | 942 | 1,038 | 898 | 8,946 | 9,951 | − 10.1 | .46 | .74 | 10,868 | 14,404 | − 24.5 |
| Graham | 225 | 344 | 237 | 3,410 | 3,237 | + 5.3 | .17 | .24 | 4,124 | 4,597 | − 10.3 |
| Crosley | 109 | 263 | ..... | 1,003 | ..... | ..... | .05 | ..... | 1,003 | ..... | ..... |
| Bantam | 119 | 142 | ..... | 975 | ..... | ..... | .05 | ..... | 975 | ..... | ..... |
| Hupmobile | 51 | 75 | 57 | 867 | 873 | − 0.6 | .04 | .06 | 968 | 979 | − 1.0 |
| Fiat | 4 | 4 | ..... | 74 | ..... | ..... | ..... | ..... | 74 | ..... | ..... |
| Miscellaneous | 51 | 31 | 104 | 467 | 1,121 | − 58.4 | .03 | .08 | 773 | 1,567 | − 59.7 |
| Total | 141,633 | 182,633 | 93,269 | 1,962,676 | 1,344,142 | + 46.0 | 100.00 | 100.00 | 2,390,509 | 1,720,233 | + 30.0 |
| Chrysler Corp. | 45,056 | 48,034 | 21,720 | 526,246 | 321,690 | + 64.0 | 26.81 | 23.93 | 640,489 | 418,526 | + 53.0 |
| Ford Motors Corp. | 23,431 | 43,759 | 21,608 | 417,783 | 295,956 | + 41.0 | 21.29 | 22.02 | 494,566 | 346,766 | + 42.4 |
| General Motors Corp. | 48,415 | 70,207 | 38,894 | 826,673 | 595,637 | + 38.9 | 42.12 | 44.32 | 1,026,891 | 782,592 | + 31.1 |
| All Others | 24,731 | 20,633 | 11,047 | 191,974 | 130,859 | + 47.0 | 9.78 | 9.73 | 228,563 | 172,349 | + 32.6 |

# Business in Brief

***Written by the Guaranty Trust Co., New York, Exclusively for* AUTOMOTIVE INDUSTRIES**

A leveling tendency of general business activity has followed the rapid expansion maintained in recent weeks. *The Journal of Commerce* index for the week ended Oct. 28 declined fractionally to 108.6 per cent. of the 1927-29 average, as compared with 109.3 for the preceding week, 109.2 for the week before that, and 90.6 a year ago.

The volume of retail sales during the fortnight ended Oct. 28, according to Dun & Bradstreet estimates, was at the highest level reached, except for pre-Christmas periods, in more than two years.

Production of electricity by the light and power industry during the second week of that period reached an all-time peak, approximately 2 per cent above the preceding record established two weeks earlier and 14 per cent above the output a year ago.

Registering a more than seasonal decline in railway freight movement during the fourth week of October, the number of cars loaded, 834,096, fell 1.3 per cent below the nine-year peak reached in the preceding week, but was 17.7 per cent greater than comparable loadings last year.

Bank debits to individual accounts in leading cities during the week ended Oct. 25 rose 12 per cent above the total a fortnight earlier, and were one per cent greater than in the corresponding period last year.

Crude oil production during the week ended Oct. 28 averaged 3,498,500 barrels daily, as compared with 3,771,550 barrels in the preceding week and 3,713,800 barrels in the second week of the month.

Bituminous coal production in the week ended Oct. 21 averaged 1,742,000 tons daily, as compared with 1,738,000 tons for the week before and 1,692,000 tons in the first week of the month.

Cotton-mill activity increased more than seasonally in the same period. *The New York Times* index standing at 138.9, as against 137.5 a fortnight earlier and 116.7 a year ago.

Private engineering construction contracts awarded during the week ended Nov. 2 registered an eighth consecutive increase over corresponding weekly figures in 1938, according to *Engineering News-Record*. Total engineering construction awards this year to date exceed by 11 per cent the comparable amount last year.

Professor Fisher's index of wholesale commodity prices for the fourth week of October declined two fractional points from the preceding week's 1939 maximum to date, standing at 83.7 per cent of the 1926 average, as compared with 83.3 two weeks ago.

Excess reserves of the member banks of the Federal Reserve system dropped $150,000,000 in the week ended Nov. 1 from the all-time peak to an estimated total of $5,380,000,000. Business loans of the reporting members increased $4,000,000 in the fortnight ended Oct. 25 to a total of $4,292,000,000, or $385,000,000 more than the corresponding amount last year.

# TNEC Swings Spotlight On Automotive Steel Prices

***Possibility Seen for Further Recognition That Large Purchases By Motor Vehicle Manufacturers Justify Special Arrangements***

One result of the Temporary National Economic Committee's probe of the factors that determine the steel market's price set-up, is likely to be further recognition of the fact that the steel purchases of automobile manufacturers, constituting the most important single group among the steel consumers, are in a class by themselves and justify arrangements differing from those in run-of-the-mill transactions in the steel market.

Much was made last spring of what were characterized as price concessions obtained by automobile manufacturers on their sheet purchases, but they were not concessions made to individual consumers but rather to the automobile manufacturing industry as a group of the most important tonnage buyers. Purchasing at these mutually agreed upon prices of requirements over the remainder of the year followed, thus replacing buying by the quarter with purchases over the entire model year. Indications point to continuance of this practice to cover the 1940 model year rather than the calendar year of 1939.

From the testimony given by the steel industry's leaders at the Temporary National Economic Committee's hearings it is obvious that, in sanctioning changes in the publicized list of steel prices, they sought to express their attitude toward the market rather than to tie themselves down to the rigid application of quotations regardless of tonnages and special conditions. It is interesting to note that one of the witnesses at the Washington hearing gave it as his opinion that much of the recent buying of steel was of a speculative character. Chicago steel producers have just announced that a survey made among their customers shows that consumption and production of steel are running neck and neck. This, however, does not impair the possibility of considerable tonnages of steel having been acquired in other markets, with a view to profiting on a subsequent price rise. Developments in the last few days have lessened the probability of this happening. The number of prophets predicting a sharp increase of export demand has also lessened.

Buying by France and Japan was reported in the copper market. The French are reported to have bought 150,000 tons, part of it from South American subsidiaries of American producers, and to have paid 12½ cents for it, while the Japanese paid 13 cents for their purchases of 500 tons in the outside market. The producers' home price for spot electrolytic continues to be 12½ cents, with outsiders having little chance of being served, while in the open market 13 cents is being asked.—W. C. H.

## Estimated Dealer Stocks of New Passenger Cars

| 1938 | July | August | September | October | November | December |
|---|---|---|---|---|---|---|
| Production—U. S. Domestic Market † | 96,975 | 53,955 | 60,177 | 171,371 | 295,366 | 305,900 |
| Retail Sales—U. S. ‡ | 153,426 | 123,711 | 90,629 | 134,984 | 241,009 | 241,623 |
| Change in Inventory | −56,451 | −69,756 | −30,452 | +36,387 | +54,357 | +64,277 |
| Inventory, first of month | 263,618 | 207,167 | 137,411 | 106,959 | 143,346 | 197,703 |

| 1939 | January | February | March | April | May | June |
|---|---|---|---|---|---|---|
| Production—U. S. Domestic Market † | 263,225 | 223,745 | 279,148 | 257,058 | 222,909 | 233,311 |
| Retail Sales—U. S. ‡ | 180,651 | 165,841 | 276,301 | 265,756 | 275,457 | 254,604 |
| Change in Inventory | +82,574 | +57,904 | +2,847 | −8,698 | −52,548 | −21,293 |
| Inventory, first of month | 261,980 | 344,554 | 402,458 | 405,305 | 396,607 | 344,059 |

| 1939 (continued) | July | August | September | October | November | December |
|---|---|---|---|---|---|---|
| Production—U. S. Domestic Market † | 142,346 | 56,233 | 155,430 | ..... | ..... | ..... |
| Retail Sales—U. S. ‡ | 229,873 | 166,172 | 139,660 | ..... | ..... | ..... |
| Change in Inventory | −87,527 | −109,939 | +15,770 | ..... | ..... | ..... |
| Inventory, first of month | 322,766 | 235,239 | 125,300 | 141,070 | ..... | ..... |

†—U. S. Census Bureau. ‡—Automobile Manufacturers Association.

# Ourselves & Government

***A Check List of Federal Action Corrected to Nov. 8***

**FEDERAL TRADE COMMISSION**

F.O.B. PRICE CASE—Trial examiners' hearing held in Ford case in Detroit on Nov. 2. Next step will be trial examiners' report. Testimony closed in GM case, with trial examiners' report having been served on respondent company. After final arguments, the FTC order is next in line. Both cases involve the FTC allegation that the companies engaged in misleading price advertising.

VS. GENERAL MOTORS—Trial examiners' report due. Rebuttal testimony concluded Sept. 11. The FTC charge is that GM dealers are required to handle GM parts exclusively.

SIX PER CENT CASE—Final arguments completed in both Ford and GM cases involving the Commission

allegation that companies engaged in misleading representation in finance plan advertising. Cease and desist orders may be next development.

FAIR TRADE PRACTICE RULES—No indication when rules, now long overdue, will be promulgated.

## GM Defense

(*Continued from page* 549)

was not proof that some had not been.

The defense, however, continued the parade with the testimony being read into the record—to be there in the event of an appeal—by counsel out of hearing of the jury. These witnesses became known as the "silent" witnesses and the parade continued until more than 100 of them had taken the stand. Judge Lindley then called a halt to that type of witness. These "silent" witnesses would be able to tell openly only their name, residence, place of business and how long a dealer. Counsel would then place in the record the number of cars, both new and used, sold each year during the term of the indictment, how many on time, what percentage of time sales to GMAC and to other discount companies and the names of the other discount companies. There were also negative answers read into the record as to whether the dealer had been coerced, forced to take cars not ordered, unable to get ordered cars, made to pay a portion of national advertising campaigns.

At one time the defense had such a number of dealer-witnesses that South Bend hotels were filled and some of the witnesses had to go to surrounding towns for accommodations.

The defense also put on the stand distribution managers of some of the divisions to explain the complexities and problems of scheduling production and distribution of cars.

## Passenger Car and Truck Production

*(U. S. and Canada)*

| | September 1939 | August 1939 | September 1938 | NINE MONTHS 1939 | NINE MONTHS 1938 | Per Cent Change |
|---|---|---|---|---|---|---|
| **Passenger Cars—U. S. and Canada** | | | | | | |
| Domestic Market—U. S. | 155,430 | 56,233 | 60,177 | 1,832,560 | 1,038,192 | + 77.0 |
| Foreign Market—U. S. | 6,195 | 5,151 | 4,982 | 123,338 | 128,949 | − 4.3 |
| Canada | 3,494 | 1,068 | 4,290 | 79,642 | 88,728 | − 10.2 |
| Total | 165,119 | 62,452 | 69,449 | 2,035,540 | 1,255,869 | + 62.0 |
| **Trucks—U. S. and Canada** | | | | | | |
| Domestic Market—U. S. | 20,772 | 29,393 | 8,699 | 392,383 | 248,594 | + 57.8 |
| Foreign Market—U. S. | 6,354 | 9,091 | 9,676 | 111,594 | 103,079 | + 8.2 |
| Canada | 427 | 2,407 | 1,799 | 30,644 | 34,978 | − 12.5 |
| Total | 27,553 | 40,891 | 20,174 | 534,621 | 386,651 | + 38.2 |
| Total—Domestic Market—U. S. | 176,202 | 85,626 | 68,876 | 2,224,943 | 1,286,786 | + 73.1 |
| Total—Foreign Market—U. S. | 12,549 | 14,242 | 14,658 | 234,932 | 232,028 | + 1.3 |
| Total—Canada | 3,921 | 3,475 | 6,089 | 110,286 | 123,706 | − 11.0 |
| Total—Cars and Trucks—U. S. and Canada | 192,672 | 103,343 | 89,623 | 2,570,161 | 1,642,520 | + 56.5 |

## New Car Registrations and Estimated Dollar Volume by Retail Price Classes*

| | SEPTEMBER, 1939 | | FIRST NINE MONTHS, 1939 | | | |
|---|---|---|---|---|---|---|
| | Units | Dollar Volume | Units | Per Cent of Total | Dollar Volume | Per Cent of Total |
| Chevrolet, Ford and Plymouth | 70,990 | $52,300,000 | 1,087,056 | 55.41 | $795,900,000 | 47.91 |
| Others under $1,000 | 53,966 | 48,700,000 | 695,701 | 35.46 | 636,600,000 | 38.32 |
| $1,001 to $1,500 | 15,213 | 18,100,000 | 150,148 | 7.65 | 175,100,000 | 10.54 |
| $1,501 to $2,000 | 569 | 900,000 | 19,021 | .97 | 29,200,000 | 1.76 |
| $2,001 to $3,000 | 809 | 1,800,000 | 9,501 | .48 | 21,600,000 | 1.30 |
| $3,001 and over | 31 | 100,000 | 618 | .03 | 28,000,000 | .17 |
| Total | 141,578 | $121,900,000 | 1,962,045 | 100.00 | $1,661,200,000 | 100.00 |
| Miscellaneous | 55 | | 631 | | | |
| Total | 141,633 | $121,900,000 | 1,962,676 | | | |

* All calculations are based on delivered price at factory of five-passenger, four-door sedan, in conjunction with actual new car registrations of each model. The total dollar volumes are then consolidated by price classes.

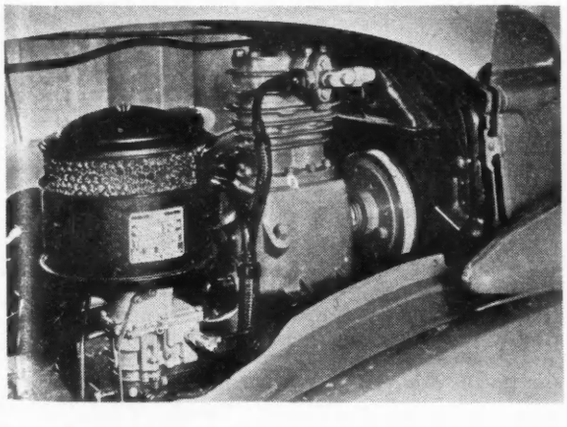
## Packard Offers Car Air-Conditioning System

An automobile mechanical refrigeration air cooling system has been announced by the Packard Motor Car Co. as a standard, factory installed, extra cost accessory. The unit also filters the air in a car and provides heat in winter.

Cooling is obtained by means of a refrigerating plant which is much the same in principle as that of any home mechanical refrigerating unit. Refrigerating coils are located back of the rear seat in an air duct with heating coils in another compartment of the same duct. An electrically-driven fan forces air through either set of coils at the will of the passengers, the filter operating as air travels through the duct.

Treated air follows along the top of the car and returns along the floor, passing under the rear seat to the coils for recooling, or reheating, and is then recirculated by the fan. Humidity is lowered by operation of cooling the air. The compressor is mounted on top of the engine and is driven from the radiator cooling fan.

According to W. M. Packer, vice-president of distribution of the Packard Motor Car Co., the cooling system offered by Packard has a cooling capacity of one and one-half tons at 60 m.p.h. and two tons at 80 m.p.h.



### At Last!

**A view of the compressor which is part of the mechanical refrigeration air cooling system offered by Packard as a standard, factory installed, extra cost accessory.**

## General Motors Reports On Increased Income

General Motors Corp. report to stockholders for the nine months ended Sept. 30, 1939, indicated a net income, before income and excess profit taxes, of $136,837,602. Net income for the third quarter was given as $9,758,729. This was compared with $51,236,615 for the first nine months of 1938 and $7,976,804 for the third quarter, 1938.

Net sales for the nine-month period in 1939 were given as $926,593,853 as compared with $694,585,433 for the same period in 1938.

The directors of the corporation at a meeting on Nov. 6 declared a dividend of $1.25 per share on the outstanding common stock, payable Dec. 12, to stockholders of record Nov. 16. The regular quarterly dividend of $1.25 per share was declared on the five-dollar preferred stock, payable Feb. 1, 1940, to stockholders of record Jan. 8, 1940.

## AUTOMOTIVE INDUSTRIES

***Summary of Automotive Production Activity***

**BUSES** Some equipment replacement is expected to come from inquiries in several Eastern Seaboard cities. Manufacturing rate continues to hover near the 60 per cent level.

**TRUCKS** Makers generally state that production and sales are steadily increasing. It is pointed out, however, that the greater activity may be attributed in part to anticipated price increases.

**TRACTORS** With fingers crossed, manufacturers expect November and December to finish strong. Higher material costs are cited as one reason for heavier buying of tractors.

**AUTOMOBILES** Despite the fact that all divisions of Chrysler Corp. were strike bound, output for the two-week period ended Nov. 11 totaled approximately 175,000 cars and trucks. With the industry maintaining its present rate, production for November should be better than 340,000 units.

**MARINE ENGINES** Except for Navy requirements, business is seasonally slack. However, two large producers report both production and sales as "exceedingly good."

**AIRCRAFT ENGINES** Output has already been stimulated by the lifting of the arms embargo. Commercial orders continue to pile up.

*This summary is based on confidential information of current actual production rates from leading producers in each field covered. Staff members in Detroit, Chicago, New York and Philadelphia collect the basic information, in all cases from official factory sources.*

(Copyright 1939, Chilton Co., Inc.)

## Census Study of Automotive Industry Begins Next Month

Manufacturers of motor vehicles will receive a new questionnaire next month from the U. S. Bureau of Census, which is completing final arrangements for Biennial Census of Manufacturers in January 1940. The questionnaire, drawn up after consultation with industry leaders, is designed to produce useful information on trends in sales, employment, payroll, costs and other factors.

In addition to its statistics on the manufacturing branch of the industry, the Bureau will publish material on parts wholesaling and retailing, and retail sales and servicing of cars. Car dealers, repair shops, service stations and other after-market factors will be covered.

Labor being such an important factor in the automotive industry, the Census Bureau will compile comprehensive statistics on number of wage earners by month, and payroll for different types of workers.

## Gasoline Restrictions Boost Bicycle Sales in England

Drastic restrictions on gasoline imposed in Great Britain as a war measure have prompted an unprecedented demand for bicycles, according to a report made public by the Department of Commerce. As a result bicycle manufacturers in Birmingham are finding it difficult to fill orders.

## Truck Production by Capacities

*(U. S. and Canada)*

| | NINE MONTHS | | | PER CENT OF TOTAL | |
|---|---|---|---|---|---|
| | 1939 | 1938 | Per Cent Change | 1939 | 1938 |
| 1½ Tons and less | 489,588 | 357,994 | + 36.5 | 91.58 | 92.59 |
| 2 to 3 Tons | 25,317 | 14,795 | + 71.0 | 4.73 | 3.83 |
| 3½ Tons and over | 10,110 | 6,979 | + 45.0 | 1.89 | 1.80 |
| Special and buses | 9,606 | 6,883 | + 39.7 | 1.80 | 1.78 |
| Total | 534,621 | 386,651 | + 38.1 | 100.00 | 100.00 |

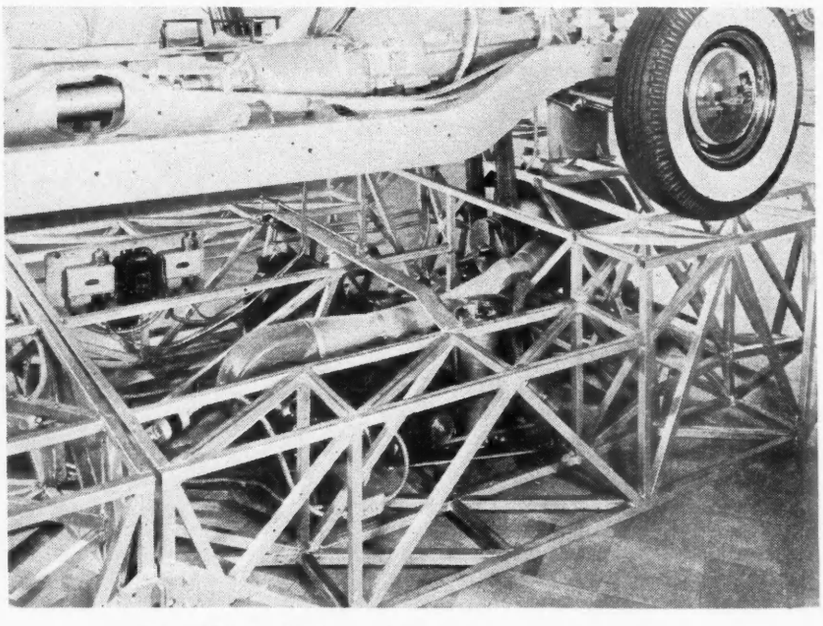
## CALENDAR

### Conventions and Meetings

National Independent Traffic League, Annual Meeting, Chicago....Nov. 23-24
National Council of Private Motor Truck Owners, Inc., Annual Meeting, New York City.....Nov. 27
Motor & Equipment Wholesalers Association, Annual Convention, Chicago .....Dec. 8-9
National Standard Parts Association, Annual Convention, Chicago....Dec. 8-9
Motor & Equipment Manufacturers Association, Annual Meeting, Chicago .....Dec. 12
SAE Annual Meeting & Engineering Display, Book-Cadillac Hotel, Detroit .....Jan. 15-19, 1940
National Aeronautic Association of the United States, Annual Convention, New Orleans, La. .....Jan. 10, 1940
National Automobile Dealers' Association, Annual Convention, Washington, D. C. .....Jan. 22-25, 1940
American Road Builders' Association, Convention, Chicago.Jan. 29-Feb. 2, 1940
Chamber of Commerce of the United States, Annual Convention, Washington, D. C.....April 30-May 2, 1940
American Society for Testing Materials, Annual Convention, Atlantic City, N. J. .....June 24-28, 1940

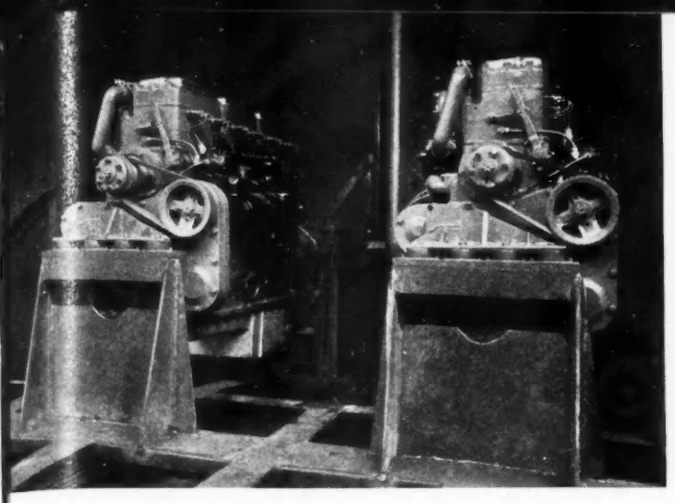
### Shows at Home and Abroad

Butte, Mont., Automobile Show....Dec. 4-5
Automotive Service Industries Show, Navy Pier, Chicago .....Dec. 11-16



## One New Drive Demonstrates Another

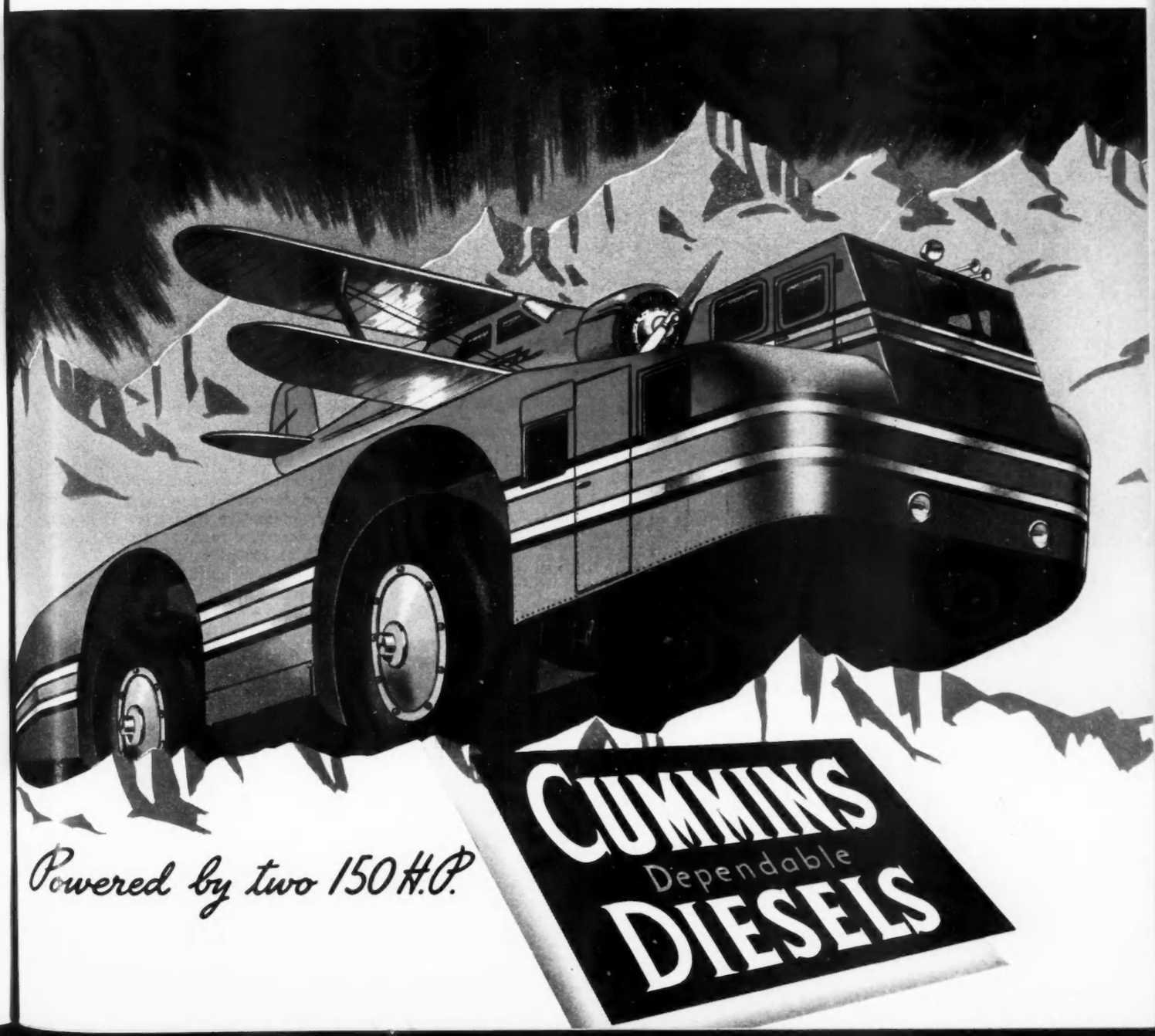
**To demonstrate its new system of gear shifting, Oldsmobile at the recent New York Automobile Show used a full-sized chassis, mounted as shown, with electric motors substituting for the car engine to provide the necessary power. A range of speeds corresponding to those used in everyday driving was obtained by the installation of the new adjustable-speed electric drive recently developed by the Reliance Electric & Engineering Co., Cleveland.**



★ The Snow Cruiser—a moving research base, has to provide housing—light—warmth—food and transportation for a crew of four scientists for long periods without outside contact. The power plant had to have a record for dependability established through thousands of similar units already in operation. The engines must be instant starting, readily adaptable to frigid climates—smooth and flexible—simple and easy to maintain and service. One engine met all the specifications—the Cummins Dependable Diesel. Send for complete details. Cummins Engine Company, SC16 Wilson Steet, Columbus, Indiana.

# SNOW CRUISER

ANTARCTIC EXPEDITION • RESEARCH FOUNDATION OF ARMOUR INSTITUTE OF TECHNOLOGY • PROJECT No. 1-69




*Powered by two 150 H.P.*

## Ettore Bugatti Designs 1500 Hp. Airplane Engine

Production of a new 1500 hp. airplane engine designed by Ettore Bugatti will soon be underway in France, according to our Paris correspondent. The engine is an almost flat double eight with light alloy cast cylinders having steel liners, overhead camshafts and centrifugal blower. The power output of 1500 hp. is obtained at 3000 r.p.m. Dry weight of the engine is one pound per horsepower.

The engine has "distance" transmission with suitable reduction ratio and permits of driving either one or two propellers. Although a high efficiency type and embodying a very extensive use of light alloys, the design has been laid out with a view to easy production. It is claimed that the frontal area is reduced by the practically flat opposed banks of cylinders and that the engine can be mounted in any desired position in the fuselage or in the wings. It is hinted that Bugatti has designed a plane especially for this type of engine.

## Armour and Lewis Plan to Consolidate in One School

James D. Cunningham, chairman of the board of trustees of Armour Institute of Technology, and Alex. D. Bailey, chairman of the board of Lewis Institute, have announced the entrance of their respective institutions into an agreement to consolidate and form the Illinois Institute of Technology. The actual consolidation of the educational program will be complete by September, 1940. Complete development of the new school contemplates the acquisition of a new campus.

## Curtiss to Erect Three New Buildings

Applications for permits to construct three new buildings, one of them to house a wind tunnel testing laboratory, have been filed by the Curtiss Aeroplane Division of Curtiss-Wright Corp. at Buffalo. Cost of the buildings was estimated at $232,000 and does not include a $65,000 job for which a permit recently was granted.

## New Truck Trailer Plant To Be Built in Lufkin, Tex.

Contracts have been let for immediate construction of a factory to manufacture truck trailers for highway freight transportation in Lufkin, Tex.

W. C. Trout, president of the Lufkin Foundry & Machine Co. and recently elected president of the State Manufacturers Association states the new plant will absorb the old Martin Wagon Mfg. Co. It will employ 50 workers upon opening and initial investment will exceed $100,000.

## Nine-Months' Record of Automotive Exports and Imports

| | SEPTEMBER 1939 | | SEPTEMBER 1938 | | NINE MONTHS ENDED SEPTEMBER 1939 | | 1938 | |
|---|---|---|---|---|---|---|---|---|
| | No. | Value | No. | Value | No. | Value | No. | Value |
| **EXPORTS** | | | | | | | | |
| Automobiles, parts and accessories | | $ 12,456,885 | | $ 14,170,906 | | $ 190,126,628 | | $ 198,507,752 |
| **PASSENGER CARS** | | | | | | | | |
| Passenger cars and chassis | 4,374 | 2,778,205 | 2,709 | 1,814,772 | 106,244 | 65,068,105 | 109,527 | 68,611,169 |
| Low price range $850 inclusive | 3,843 | 2,244,192 | 2,327 | 1,336,481 | 94,910 | 53,104,254 | 95,694 | 53,590,590 |
| Medium price range over $850 to $1,200 | 455 | 417,350 | 287 | 278,538 | 9,735 | 9,267,303 | 11,778 | 11,488,057 |
| $1,200 to $2,000 | 70 | 101,918 | 30 | 43,902 | 1,314 | 1,941,053 | 1,592 | 2,359,398 |
| Over $2,000 | 6 | 14,745 | 65 | 155,851 | 285 | 755,495 | 463 | 1,173,124 |
| **COMMERCIAL VEHICLES** | | | | | | | | |
| Motor trucks, buses and chassis (total) | 3,310 | 2,501,592 | 8,064 | 5,780,465 | 86,252 | 53,813,914 | 87,027 | 56,351,892 |
| Under one ton | 439 | 178,019 | 499 | 236,398 | 12,816 | 5,391,657 | 12,659 | 5,390,405 |
| One and up to 1½ tons | 2,146 | 1,350,711 | 6,385 | 4,085,044 | 60,056 | 32,998,953 | 59,147 | 33,026,551 |
| Over 1½ tons to 2½ tons | 575 | 600,377 | 755 | 602,490 | 9,647 | 8,770,582 | 9,498 | 7,653,479 |
| Over 2½ tons | 150 | 372,525 | 353 | 578,038 | 3,154 | 6,128,454 | 4,604 | 9,202,427 |
| Bus chassis | | | 72 | 278,495 | 579 | 524,628 | 1,119 | 1,079,030 |
| **PARTS, ETC.** | | | | | | | | |
| Parts except engines and tires | | 2,716,944 | | 2,949,352 | | 29,849,805 | | 34,916,527 |
| Automobile unit assemblies | | 3,210,963 | | 2,548,212 | | 29,365,907 | | 27,159,203 |
| Automobile parts for replacement (n.e.s.) | | 404,358 | | 336,845 | | 3,023,195 | | 2,623,213 |
| Other automobile accessories (n.e.s.) | 781 | 389,423 | 663 | 373,116 | 13,565 | 4,511,092 | 11,352 | 4,410,485 |
| Automobile service appliances | 62 | 3,956,423 | 64 | 3,000,252 | 1,055 | 46,141,039 | 675 | 31,387,068 |
| Airplanes, seaplanes and other aircraft | | 8,051,901 | | 1,189,818 | | 78,238,521 | | 16,383,080 |
| Parts of airplanes, except engines and tires | | | | | | | | |
| **INTERNAL COMBUSTION ENGINES Stationary and Portable** | | | | | | | | |
| Diesel and semi-Diesel | 39 | 205,784 | 32 | 61,883 | 401 | 1,460,607 | 367 | 1,597,458 |
| Other stationary and portable | | | | | | | | |
| Not over 10 hp. | 1,136 | 66,984 | 1,706 | 72,389 | 10,899 | 634,767 | 11,508 | 636,890 |
| Over 10 hp. | 200 | 104,599 | 175 | 69,811 | 1,514 | 958,807 | 2,885 | 1,312,754 |
| Engines for: | | | | | | | | |
| Motor trucks and buses | 1,887 | 269,195 | 1,633 | 189,608 | 20,400 | 2,514,128 | 20,861 | 2,308,932 |
| Passenger cars | 620 | 99,325 | 1,998 | 159,483 | 19,237 | 1,720,896 | 31,781 | 2,587,520 |
| Aircraft | 78 | 372,589 | 67 | 451,892 | 1,298 | 9,183,705 | 951 | 5,467,256 |
| Accessories and parts (carburetors) | | 278,263 | | 186,117 | | 2,160,507 | | 2,063,967 |
| **IMPORTS** | | | | | | | | |
| Automobiles (dutiable) | 41 | 38,599 | 28 | 34,405 | 454 | 334,803 | 428 | 291,197 |

## PUBLICATIONS

**"Flame Cleaning and Dehydrating,"** an eight-page booklet issued by the Air Reduction Sales Co., New York, N. Y., discusses the use of this process to halt deterioration of old steel structures by means of paint burning and surface conditioning.*

**"Fourteen Reasons for Automatic Lubrication"** is the title of a folder published by the Bijur Lubricating Corp., Long Island City, N. Y.*

Two catalog sections, one on **"Bus and Diesel Batteries"** and the other on **"Truck Batteries,"** have been prepared by the B. F. Goodrich Co., Akron, Ohio.*

The White Motor Co., Cleveland, has issued a new broadside giving description and specifications of its **White Horse truck.***

The Howell Electric Motors Co.'s new Type K **totally-enclosed and fan-cooled motor** is described in bulletin K-20.*

**Pneumatic remote controls** manufactured by the Tomkins-Johnson Co., Jackson, Mich., are covered in bulletin RC-4.*

**Welding machines,** including a new electric arc welding generator, built by Wilson Welder & Metals Co., New York, are described in a recently issued 18-page bulletin.*

Engineering data on **ball bearings** and allied products manufactured by the Bearings Co. of America, Lancaster, Pa., are contained in a new catalog issued by the company.*

A number of new applications for **Cerromatrix**—a low-temperature-melting alloy composed of bismuth, lead, tin and antimony, that expands slightly on solidification—are described in a 36-page booklet issued by the Cerro De Pasco Copper Corp., New York, N. Y. This metal is used chiefly as a matrix for locating and securing punch and die parts permanently in place, for anchoring machine parts without the expense of drive fits, etc.*

**"A Change Needed in Federal Labor Policy"** is the title of a booklet-editorial by Allen W. Rucker in collaboration with N. W. Pickering, president, Farrel-Birmingham Co., Inc., Ansonia, Conn.*

*Obtainable from editorial department, AUTOMOTIVE INDUSTRIES. Address Chestnut and 56th Sts., Philadelphia.

## Metal Developments

(*Continued from page* 518)

on display the new Perliton carburizing bath designed for small parts production; also its line of cutting fluids.

The Electric Furnace Co. had a pictorial review of recent heat treating installations, particularly a new unit supplied to one of the largest plants in the automotive industry. This unit will be described in AUTOMOTIVE INDUSTRIES in an early issue.

Striking demonstration of advances in the art of heat treating was given by The Ohio Crankshaft Co., whose attractive booth featured applications of Tocco selective induction hardening. In a comparatively short space of time the Tocco process has been adopted by some of the leading producers of the automotive industry for hardening crankshafts, camshafts, and a variety of other parts. Several variations of the Tocco Junior machine were shown, each of them representing new applications in automobile plants.

Needless to say, the exposition was replete with all manner of instruments and testing devices for the laboratory and the production line. One of the

familiar items was Magnaflux inspection which is so widely used in aircraft and motor car parts inspection. It merits particular attention because of its endless applications as a non-destructive and extremely rapid method of detecting minute surface flaws. New laboratory item is the Sargent high speed electrolytic analyzer designed to speed up routine laboratory work. Bausch & Lomb showed many items of its line of scientific equipment, most interesting of these being the new edition of the large Littrow quartz spectrograph for the analysis of metals and alloys, which has been widely adopted in the automotive industry.

In the field of metal cleaning there was the display of G. S. Blakeslee with examples of solvent degreasers and a new compact alkaline washing machine for small metal parts. This machine combines wash, rinse, and dry in a completely automatic cycle. Interesting feature of the machine is the modern "streamlining" focusing attention on the niceties of tailoring the external sheet metal. Another entrant in this field was the well known Ideal washing machine line produced by N. Ranshohoff, Inc. A line of portable, electrically operated degreasers which can be moved about to suit the location of the work was shown by the Phillips Mfg. Co. Examples of the Wheelabrator Tumblast were shown by the American Foundry Equipment Co., while the Michiana Products Corp. exhibited its new sand blast gun which is said to assure fine surface finish despite its fast action.

Continental Machine Co. introduced the Doall combination milling and die sinking machine having a full hydraulic main spindle drive. It is a compact, universal machine, adaptable to many tasks in parts plants and mass production tool rooms. For die sinking, it has a small tracer-duplicator spindle operated hydraulically with automatic electrical controls. The tracer action is said to be accurate within one-quarter thousandth of an inch.

---

## Double Standards Confuse Labor Issues

(*Continued from page* 522)

in the plant. It also denies there is a strike, while admittedly using the tactics of a strike, and calls it a lock out. And it denies that its campaign of 'slow downs,' job 'skipping' and production sabotage, begun more than two months ago, is to force us into a closed (union) shop.

"But the facts speak for themselves."

In the days of N.R.A., for the first time, we had embodied in our national law, under the provisions of the well-known Section 7 (a), a definite discrimination between employers and labor organizers in respect to the prohibition of "interference, restraint, or coercion" of employes in exercising their right "to organize and bargain collectively through representatives of their own choosing."

In the Wagner Act this discrimination was made even more emphatic by separating the right from the prohibition and placing the latter in the section of the law relating to Unfair Labor Practices of Employers.

The employer must not interfere. He must not restrain. He must not coerce. And Heaven's Recording Angel surely knows that he is compelled to walk a narrow, thorn-edged path in keeping within the hair-like narrowness of the law's interpretation. Labor organizers? That's different, and the fact that it is different simply does not make sense when the effects on the fundamental individual rights of workers and the economic interests of the country as a whole are accepted as the correct indicators of the law's soundness or unsoundness. However, when effects on the special privileges and vested interests of the labor organizers are taken as the guides to rightness, the law, as it stands today, does make sense. It is only then that it does.

The clearest way to view and the

here!
there!
everywhere!
dag
COLLOIDAL GRAPHITE
BEATS HEAT
. . . . in conveyors and baking ovens, in die casting and permanent mold equipment, in ceramic and glass making machinery, in new places every day.
This material is now available in a form that permits stable suspensions, even in low viscosity fluids such as kerosene, spindle oils, etc. Where boundary conditions exist, "dag" colloidal graphite acts as an ideal teammate for oil. In the presence of high temperatures, dispersed in fluids that quickly evaporate, only a positive, clean, durable lubricating film of graphite remains on the bearing surface. It takes over the load at the point where oil leaves off.
Send for brochure describing the properties of "dag" colloidal graphite and 182 uses in industry. You or your oil supplier can easily add "dag" to your present lube or to selected petroleum fluids.
FOR STEAM CYLINDERS
FOR COMPRESSORS
FOR HIGH TEMPERATURE LUBRICATION
dag
COLLOIDAL PRODUCTS
ACHESON COLLOIDS CORPORATION
PORT HURON, MICHIGAN

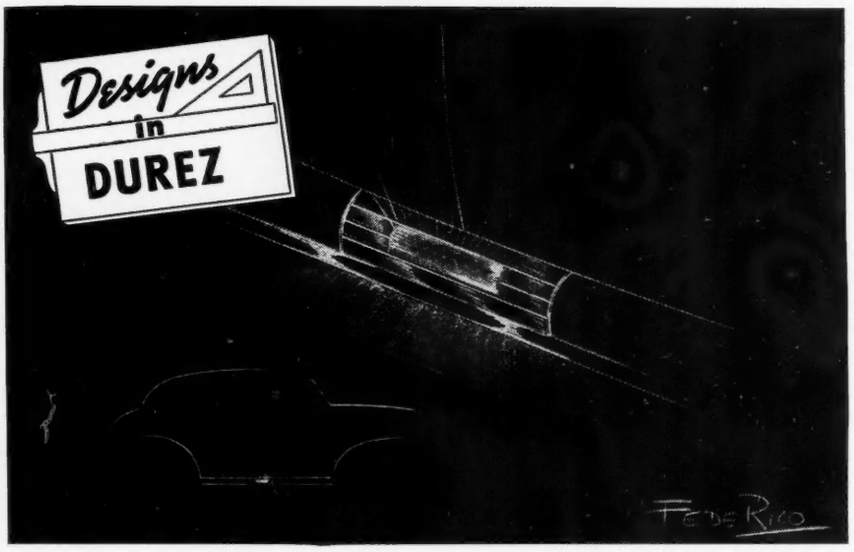
easiest way to understand what is taking place in Detroit today and what has taken place throughout the automotive industry in the realm of labor relations during the past two years is to start with the easily supported conviction, the obvious assumption, that monopoly—in this case a legally protected labor monopoly — is at work using methods which anti-monopolists have hitherto most violently condemned and government, through law and prosecution, up to this time, has sought most actively to squelch. What is taking place is not the protection of the worker in his right to free choice but the regimentation of the worker and the curtailment of his constitutional rights by a monopoly controlled by professional organizers to whom he pays tribute for the privilege of earning a living wage. Trying to look at the situation in any other way, the intelligent observer finds himself in a heavy fog.

We say in the text of our law that the working man shall be protected in an ancient and inalienable right. In the interpretation and administration of the law we either take that right away or seriously curtail it.

We say in the text of our law that our working men shall not be denied the privilege of collective bargaining. And yet we see them today, through the law's operation, forced into a type of negotiations peculiar to power politics which are not truly collective and resemble bargaining only slightly less than did Germany's negotiations with Poland. The union bosses make *demands* and add "or else". We say in our law that: "Experience has proved that protection by law of the rights of employes to organize and bargain collectively safeguards commerce from injury, impairment, or interruption and promotes the flow of commerce". The purpose of the law (The National Labor Relations Act) as set forth in its title clause is: "To diminish the causes of labor disputes". The number of causes may possibly have been diminished but the number of disputes has definitely been increased since the law went into effect, according to figures released this month by the Chamber of Commerce of the State of New York.

So now, what? Industry is in a chaotic state. Labor agitators are enjoying their hey-day. Public spirited, work making, wage paying employers are ham-strung. Unemployment still runs into unknown millions. New enterprise is almost completely discouraged. New jobs in new industries are not being created. Production in many established industrial plants is being curtailed. It is not too much to say that the American System of Enterprise which "thrives only by the creation of individual opportunity" is seriously threatened.

We should shake ourselves out of our present confusion and ask ourselves what we are going to do about things as they are. We should ask ourselves whether we shall let irresponsible labor organizers increase their hold on and their control over our industrial structure. If we say no, we should exchange our present laws for new ones that take account of fundamentals. We should see to it that basic rights are restated and upheld, that interference with inter-state commerce *from any source* is treated as a detriment to the public good, that freedom of speech is a right enjoyed by all, that coercion and intimidation are the privileges of none. We should recognize that monopoly is monopoly wherever it exists and judge its virtue or its viciousness by a single standard.


# Idea For a SAFETY-STEP LIGHT

Most of this year's cars have no running boards. Passengers step right out of riding compartments. So what could be handier than a light at floor level, between front and rear doors, to help you "watch your step" at night?

Joseph B. Federico shows how this could be done. The light would shine automatically when the door opened, showing up the ground beneath your foot. When the doors were closed it would show a red light to make the sides of the car more visible at intersections.

A housing of Durez plastic would protect the light, enhance its appearance, harmonize with the trim of the car. Molded of Durez it would naturally stand hardest wear and always retain its lustrous appearance. Best of all, it would be produced economically, formed and finished in one simple operation!

May we tell you more about this and other "Designs in Durez" for the modern motor car? Just write Durez Plastics & Chemicals, Inc., 911 E. Walck Road, North Tonawanda, N. Y.

**DUREZ PLASTICS & CHEMICALS, INC.**

**Plastics That Fit The Job**


## MEN and MACHINES

(*Continued from page* 548)

The machine is available either as a plain cutter grinder or as a universal machine, the only difference being that more equipment is supplied with the universal model. Included as equipment with both models is a universal work head which takes milling cutters having the standard No. 50 (3½ in. per ft.) taper; supplied with it are reducing collets for No. 12, 10, 9 and 7 B & S and No. 2 Morse tapers. Also supplied is a universal type left-hand

footstock which will take No. 9 B & S tapers. Both the universal work head and the left-hand footstock are provided with clearance angle setting dials. In addition to the plain equipment, the universal model is provided with attachments or internal, surface, cylindrical and gear cutter grinding. Other attachments are available for hob, form, face mill and long reamer grinding.

COMPRESSED air actuates the tapping head in both drive and reverse directions on the new "Universal" air operated tapping machine developed by the Procunier Safety Chuck Co., Chicago. It is said that the double-acting straight-in-line compensating springs with the adjustable tension housing are responsible in large measure for the precision tapping achieved by this machine. Rate of feed for both tapping "in" and backing out the tap is controlled by two needle valves; one valve for the down stroke, the other for the up stroke. These valves, operated independent of the length of the spindle stroke, are readily accessible and accommodate the various sizes and pitches of taps on the different types of materials. Spindle travel is adjustable from ¼ in. to 3¼ in. by means of a trip arm. An automatic control valve can be opened for continuous operation, set for foot-button control or turned to the "off" position.

Capacity of the machine ranges from No. 2 tap to 5/16 in. in steel, ⅜ in. in cast iron, ½ in. in brass, using two interchangeable tapping heads. Four speeds (390, 745, 1280 and 2050 r.p.m.) are available from a vee belt drive through four step cone pulleys.

AN operation requiring a "hole" broach almost two feet in circumference was recently added to the production sequence in the plant of a prominent tractor manufacturer. The operation is for broaching the internal bore of large steel tractor ring gears and was developed in order to increase accuracy in subsequent manufacturing operations in which the gear teeth are machined in reference to the I.D. The machine used for this operation is a standard Colonial Broach Co. open side utility press rated at 10 tons.

The gear is located in a fixture mounted on a table which may be raised or lowered as to height in relation to the ram through the provision of cross keyways in the face of the column. The broach itself is approximately 15 in. long and is built up from a number of individual rings, the lower rings being provided with chip breakers. The operation is of the semi-finishing type, a final finishing operation being provided later in the machining sequence.

The broach is guided at top and bottom throughout the stroke. It is released by the ram at the bottom of the work stroke to permit removing the broached forging. An automatic broach handler is provided below the fixture table which raises the broach into a puller after removal of the part, before the ram returns to the top. The machine is set for a stroke of 24 in., a 30 ft. per min. cutting and 60 ft. per min. return stroke giving a high production for the operation.

HERE are some additional new developments in machine tools and allied equipment: Thread chasing attachments for use on Brown & Sharpe Nos. 00, 00G, 0, 0G, 2 and 2G automatic screw machines (high speed); hydraulic die handling truck manufactured by the Lyon Iron Works, Greene, N. Y. It is furnished with a die separating and turning device, and a special adjustable clamp for holding various size dies; a new series of Oxweld cutting nozzles which are said to increase oxy-acetylene cutting precision. Linde Air Products Co. is the manufacturer; comparator by Jones & Lamson Machine Co., Springfield, Vt., specially designed for inspecting spherical surfaces, such as those of balls used in precision ball bearings. Channel lubricated roller chain, which conforms to American Standard dimensions and is completely interchangeable with all other standard roller chains, announced by Morse Chain Co.

"SERVICE PROVED" OILS
Cut Costs for Vacuum Cleaner Company

Prolonging tool life—thus building efficiency and consequent profits—is the job of Service Proved Industrial Oils and the Cities Service Lubrication Engineers' Service.

The Electric Vacuum Cleaner Co., in machining more than 2,000 outer ball bearing races a day, uses Cities Service cutting oils on Gridley automatics, because they have found that these oils give them longer tool life and more economical operation.

The Cities Service Lubrication Engineers' Service will help you solve cutting oil problems. There is no charge for this consulting service. Also you may secure a new booklet on metal cutting lubrication by checking the box indicated on the coupon.

CITIES SERVICE
Cutting Oils
"SERVICE PROVED"

FREE!
Just Clip and Mail

CITIES SERVICE OIL CO.
Sixty Wall Tower—Room 1626J, New York.

☐ Please send full details of your Lubrication Engineers' Service.
☐ Please send me a copy of your free folder "Metal Cutting Lubrication."

Name..... Title.....
Business Address.....
Firm Name.....
City..... State.....

# This Body Hauls

## IT'S MADE OF REPUBLIC DOUBLE STRENGTH STEEL

Five years ago, the coal company operating this truck equipped it with a body made of 12-gauge Republic Double Strength Steel instead of 3/16-inch carbon steel formerly employed, and cut one ton from the dead-weight. This meant an extra ton of pay load hauled free — every trip.

This body has seen service on three different chassis. The only repair expense charged against it was for damage caused by collision with a street car. And after five years of steady service, carrying stoker coal of high sulphur content and treated with calcium chloride, micrometer readings show the metal to be a full 12-gauge. This is a real tribute to its remarkable resistance to corrosion, in view of the fact that the life of the heavier bodies formerly used under the same conditions was never more than four or five years.

**REPUBLIC STEEL CORPORATION**
GENERAL OFFICES: CLEVELAND, OHIO
ALLOY STEEL DIVISION: MASSILLON, OHIO

UNION DRAWN STEEL DIVISION • STEEL AND TUBES DIVISION • BERGER MANUFACTURING DIVISION
NILES STEEL PRODUCTS DIVISION • TRUSCON STEEL COMPANY

**REPUBLIC DOUBLE STRENGTH STEELS**
SHEETS • STRIP • PLATES • BARS • BOLTS • NUTS • RIVETS
LIGHTER • STRONGER • MORE CORROSION-RESISTANT